

Principle	Banksia Woodlands TEC	Carnaby's, Baudin's and Forest Red-tailed Black Cockatoo's
		It is proposed that offset sites will be efficiently managed in a transparent manner by the DBCA or SSJ. Offsets and associated conservation measures will be reviewed and approved by the DWER, DAWE and other government agencies including the DBCA recognised for applying scientifically robust methods in conservation management.
Suitable offsets must have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced.		The PTA propose to enter into an MOU with the DBCA, SSJ, WAPC and a Grant agreement with Murdoch University as required to implement the management of the offsets. This will include transparent governance and regular reporting on implementation and performance. Regular audits to assess compliance against the site management plans will be conducted.
Suitable offsets must be informed by scientifically robust information and incorporate the precautionary principle in the absence of scientific certainty.		Offsets will be informed by scientifically robust information and will incorporate the precautionary principle in the absence of scientific certainty.
Suitable offsets must be conducted in a consistent and transparent manner.		As a State Government Proposal, offsets will be conducted in a consistent and transparent manner, with implementation and performance reported annually to DWER and DAWE.

## 8. Offset Proposal Governance

The following sections describe the governance structure for the offsets. Governance will be specified and bound within specific MOU agreements.

### 8.1. Timelines and milestones

Milestones and timing for implementation of offsets including funding and delivery of offsets will be agreed with the DBCA, SSJ, Murdoch University and WAPC as part of the development of the various MOUs or other mechanisms. Timeline progression, achievement of milestones and budget will be reported monthly or annually in accordance with the terms of the MOU.

### 8.2. Monitoring to assess offset implementation

The PTA will monitor offset delivery, implementation of management measures and overall progress through liaison with the DBCA, SSJ and Murdoch University and review of monthly or annual reports. This process will be conducted in accordance with the MOUs/Grant Agreements and would include reporting on the completed management measures, those scheduled, those not completed and allocated budget. Specific monitoring results will also be reported.

The MOU or other mechanism between the SSJ/DBCA and the PTA (and other parties as required) will dictate the format, content and timing of reporting required. Monitoring would be supported for the first five years and only extended if monitoring indicates that success criteria have not or are unlikely to be met at seven years.

### 8.3. Reporting and timing

The PTA will provide an annual Compliance Assessment Report to DWER and/or DAWE (as required) regarding:

- The activities undertaken in the previous 12 months for each offset.
- The activities proposed in the next 12 months for each offset.
- A summary of compliance with the final Offsets Strategy with regard to each offset.
- An evaluation of the results of site assessments and monitoring to identify progress in meeting the success criteria.

### 8.4. Financial arrangements

The PTA will fully fund the relevant actions proposed under this Offsets Strategy including the:

- Provision of funding for on-ground management measures to maintain the offset sites' vegetation condition and habitat.
- Contribution of funding to Murdoch University for the Black Cockatoo research proposal.

### 8.5. Review and revision

The Offsets Strategy will be revised based on one or more of the following:

- Notification of environmental conditions (under both the EP Act and EPBC Act);
- Confirmation of the final project footprint (if changed);
- Revision of significant environmental impacts (if required);
- Receipt of information addressing any data gaps (if required and where available); and
- Any additional offset sites that become available for use in METRONET projects (if suitable or preferable).

## 9. Stakeholder Consultation

Stakeholder consultation in relation to the coordination, development and implementation of this Offsets Strategy conducted to date is summarised in Table 31.

Please note that the PTA is progressing multiple offsets strategies for METRONET proposals, and this may be reflected in the below discussions.

**Table 31: Offsets Strategy stakeholder consultation**

Stakeholder <sup>1</sup>	Date	Issues/topics	PTA response/outcome
WAPC/DPLH	28 July 2020	Proposed meeting to discuss the Proposal's Draft Offsets Strategy and the use of State acquired Advanced offset sites.	TBA
City of Bayswater	July 2020	Proposed meeting to discuss the Proposal's Draft Offsets Strategy and potential offset opportunities within the City, for future consideration.	TBA
City of Swan	17/06/2020	Meeting to discuss the Proposal's Draft Offsets Strategy and potential offset opportunities within the City, for future consideration. Included discussion with representative from Friends of Bennett Brook regarding potential on ground offsets.	The PTA to look at the offset site proposed at the meeting and other potential offset sites and methods. The City of Swan to provide any further potential offset options.
MRWA METRONET DWER DBCA DAWE	08/05/2020	Discussed the proposed Malaga to Ellenbrook Rail Works Proposal offsets strategy and the use of State acquired Advanced offset sites.	The PTA is to include information in the Offsets Strategy regarding on-ground management of the Lowlands site. PTA to liaise with DBCA with regards to changes to wetlands mapping dataset.
MRWA METRONET	05/05/2020	Offsets meeting - discussed Offsets Strategy for Malaga to Ellenbrook Rail Works.	Schedule additional offset meetings to further collaborate as required.
SSJ	06/04/2020	Discussed the option of SSJ carrying out the site management of the Keysbrook site.	The PTA provided a written offer to the SSJ for the management of the Keysbrook site.
SSJ	21/01/2020	Discussed the option of SSJ carrying out the site management of the Keysbrook site.	SSJ to follow up on internal departments if the Shire would be able to implement a management plan.
EPA Services MU	23/10/2019	Discussed the Black Cockatoo Research Proposal.	Research proposal finalised. Details on which will be provided under separate cover.
DBCA	10/10/2019	Proposed management and funding arrangement for the Lowlands offset proposal discussed.	DBCA to provide proposed management actions and funding requests as discussed in the meeting in writing.
MU	21/08/2019	Discussed the PTA's comments on Murdoch's Black Cockatoo research proposal and the revised proposal	PTA to provide the revised proposal to the State and Commonwealth and discuss the

Stakeholder <sup>1</sup>	Date	Issues/topics	PTA response/outcome
		prepared to address the PTA's comments.	proposal with all stakeholders including Government in October 2019 teleconference.
DBCA	21/08/2019	Discussed the proposed Lowlands Offsets Strategy and site management.	Schedule further meeting to discuss details, Keysbrook and Ningana Bush Forever Offset Sites.
MRWA	09/08/2019	Offsets meeting - discussed shared offset opportunities.	Schedule additional offset meeting to further collaborate as required.
EPA Services DPC	25/06/2019	Offsets teleconference to discuss the Proposal offsets strategy and the Commonwealth's comments on the draft Offsets Strategy.	The PTA is to provide written evidence to DWER to support the allocation of advanced offset sites to METRONET and to discuss the draft offset Calculator.
WAPC	24/05/2019	Discussed the proposed Proposal offsets strategy, the use of State acquired Advanced offset sites and the proposed Bush Forever offset.	The PTA to schedule a further meeting to discuss the proposed Bush Forever offset with all relevant stakeholders.
DWER	23/05/2019	Discussed the proposed Proposal offsets strategy and the use of State acquired Advanced offset sites.	The PTA is to provide written evidence to DWER to support the allocation of advanced offset sites to METRONET.
WAPC	1/05/2019	Discussed WAPC's historical purchase of land for the Strategic Assessment of the Perth and Peel Region (SAPPR) for future offset requirements including METRONET.	A future meeting with EPA Chairman Dr Tom Hatton was scheduled to discuss further, with a discussion paper and briefing notes to the Transport Minister and the Commonwealth Minister of Environment summarising the matter to be prepared.
DPC DBCA METRONET	5/04/2019	<ul style="list-style-type: none"> <li>Coordinated approach to METRONET offsets.</li> <li>Proposed METRONET Offsets Strategy, specifically, land acquisition options and strategy.</li> <li>State and Commonwealth Offsets Strategy timeframes.</li> <li>Use of SAPPR offsets.</li> </ul>	<ul style="list-style-type: none"> <li>PTA scheduled a future meeting with EPA Services to discuss meeting outcomes.</li> <li>The PTA agreed to provide DPC, DBCA, and WAPC with regular METRONET offsets.</li> </ul>
DPC DBCA	3/04/2019	Discussed land acquisition offset options for each Proposal significant residual impact including timing, strategy, risks and issues.	The PTA strategised potential sites and agreed to conduct further research prior to presenting them to EPA Services for consideration.
WAPC	27/03/2019	Discussed WAPC purchased advanced offset sites available for METRONET use.	PTA to obtain written authorisation to use the sites for METRONET.

Stakeholder <sup>1</sup>	Date	Issues/topics	PTA response/outcome
DPC METRONET	27/03/2019	<ul style="list-style-type: none"> <li>Coordinated approach to METRONET offsets.</li> <li>Proposed METRONET Offsets Strategy, specifically, land acquisition options and strategy.</li> <li>State and Commonwealth Offsets Strategy timeframes.</li> <li>Use of (SAPPR) offsets.</li> </ul>	PTA to obtain written authorisation to use the SAPPR offset sites for METRONET.
DBCA	21/03/2019	Discussed land acquisition offset options for each Proposal significant residual impact including timing, strategy, risks and issues. DBCA proposed acquisition sites and strategies.	Schedule further meeting as required.
DPLH	14/03/2019	Discussed cost to manage Bush Forever sites, namely Bush Forever Site north of Roe Highway and WAPC/DBCA reserve management process.	Schedule further meeting as required.
MRWA	1/03/2019	Discussed co-funding of Murdoch's Black Cockatoo research proposal offset case studies/experience/examples.	MRWA and the PTA agreed to continue to liaise with regards to co-funding Murdoch Black Cockatoo research.
MU	1/02/2019	Discussed Murdoch's Black Cockatoo research proposal.	Murdoch to provide a Black Cockatoo research proposal to the PTA for consideration and inclusion within the Offsets Strategy.
DBCA ELA	24/10/2018	Discussed land acquisition offset options for each Proposal significant residual impact including timing, strategy, risks and issues. DBCA proposed acquisition sites and strategies.	ELA to prepare an Offsets Strategy.

<sup>1</sup> Stakeholders are identified using the following abbreviations:

DAWE - Department of Agriculture, Water and the Environment (Commonwealth)

DBCA - Department of Biodiversity, Conservation and Attractions (State)

DPC - Department of Premier and Cabinet (Commonwealth)

DPLH - Department of Planning, Lands and Heritage (State)

DWER - Department of Water and Environmental Regulation (State)

ELA - Ecological Australia (Consultant)

EPA Services - Environmental Protection Authority (State)

SSJ - Shire Serpentine Jarrahdale (Local Government)

MRWA - Main Roads Western Australia

MU - Murdoch University

WAPC - Western Australian Planning Commission (State)

## **10. Finalisation and Implementation of Offsets**

This Draft Offsets Strategy will be submitted to the State and Commonwealth for consideration as part of the Proposals Environmental Review Document. The Offsets Strategy will be finalised following comments from regulators, conditions imposed by the State and/or Commonwealth and results of further PTA investigations or surveys into the Proposal or offset land acquisition sites.

## 11. Conclusion

After considering all the information provided in the State and Commonwealth guidance documents and tools, the holistic environmental value of an impacted factor, including information specific to the Proposal, the PTA has calculated the significant residual environmental impacts.

The PTA propose to use direct land acquisition offsets and one indirect research offset to counterbalance the significant residual impacts from the Proposal. The sites selected as offset sites are owned by the State and are managed (or will be managed) by the DBCA or SSJ.

The PTA has provided this strategy to demonstrate the approach to offsets; to demonstrate offsets are available for counterbalancing the significant residual impacts of the Proposal, and that proposed offsets meet both State and Commonwealth requirements.

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# Appendix A – Residual Impact Significance Model

Environmental Factor	Predicted Direct Impact(s)	Mitigation			Unacceptable significant impacts	Significant impacts that will be offset	Insignificant impacts that will not be offset
		Avoidance	Minimisation	Rehabilitation			
Flora and Vegetation	<ul style="list-style-type: none"> <li>Permanent loss of 59.9 ha of native vegetation in Degraded or better condition from within a 249 ha Footprint including: <ul style="list-style-type: none"> <li>10.05 ha of Commonwealth listed Banksia Woodlands of the Swan Coastal Plain (SCP) Threatened Ecological Community (TEC), synonymous with the State listed Priority 3 Banksia Dominated Woodlands of the SCP Priority Ecological Community (PEC) within the Footprint comprising of two patches, Patch 1 (8.54 ha and Patch 5 (1.51 ha).</li> <li>17.2 ha of regionally significant bushland within Bush Forever site 304 (Whiteman Park).</li> <li>112.3 ha of wetland vegetation in Completely Degraded or better condition, of which 1.9 ha is associated with Conservation Category Wetlands (CCWs) and 60.4 ha is associated with Resource Enhancement Wetlands (REW).</li> </ul> </li> <li>Severance of regional ecological linkages.</li> </ul>	<ul style="list-style-type: none"> <li>The Proposal design has been modified iteratively to avoid known populations of, and direct impacts to, threatened flora and native vegetation, with a particular emphasis on avoiding vegetation in Degraded or better condition, as far as practicable.</li> <li>The establishment of Native Vegetation Retention Areas (NVRAs) within the Development Envelope. NVRAs are designated no-clearing zones within the Development Envelope to reduce the impacts on native vegetation, Bush Forever site 304 (Whiteman Park), avoid clearing mature trees and/or CCWs/REWs.</li> <li>The Proposal has been designed to avoid three patches (Patch 2, 3 and 4) of TEC that were mapped within close proximity to, or within, the Development Envelope and Footprint.</li> <li>A significant portion of the highest quality vegetation within Patch 1 TEC (6.95 ha, approximately 30% of the total mapped area) has been incorporated into a NVRA.</li> <li>A significant portion of Patch 1 TEC (7.74 ha, approximately 33% of the total mapped area) has been excluded from the Development Envelope.</li> <li>A significant portion of Patch 5 TEC (35.94 ha, approximately 97.8% of the total mapped area) has been excluded from the Development Envelope.</li> <li>The Proposal design has been developed to avoid clearing of CCW in Good – Degraded condition wherever practicable.</li> <li>Avoidance of areas of Bush Forever sites 198 Beechboro Road Bushland, Ballajura; 200 Caversham Airbase Bushland, West Swan / Whiteman; and 305 Bennett Brook Reserve.</li> </ul>	<ul style="list-style-type: none"> <li>Refinement of the Development Envelope and Footprint to the minimal extent necessary whilst accommodating the construction and operation of the project, allowing some degree of flexibility in detailed design.</li> <li>The Development Envelope was positioned so as to minimise impacts on Bennett Brook by crossing it at its narrowest practicable point, commensurate with the requirements of rail design geometry.</li> <li>The Footprint has been aligned along the edge of Drumpellier Drive to minimise clearing within the Bush Forever Site 304 (Whiteman Park) eastern edge.</li> <li>The majority of the alignment has been designed to avoid dissecting areas of native vegetation, thus limiting edge effects to one side of the Proposal.</li> <li>Design included a bridge over Bennett Brook to minimise any interruptions to the dispersal of flora and fauna along ecological linkages.</li> <li>Permanent access paths where the rail alignment crosses the junction between Drumpellier Drive and Gnangara Road have been relocated to minimise the impact on TEC Patch 5.</li> <li>Embankment and alignment have been modified to minimise the impact on TEC Patch 5.</li> <li>The location of the dive structure under the southbound carriageway of Tonkin Highway was modified to allow the rail to cross Patch 1 through the lowest condition vegetation possible.</li> <li>The Development Envelope and the Footprint have been amended to minimise impacts on several CCWs along the alignment.</li> </ul>	<ul style="list-style-type: none"> <li>Areas cleared for the Proposal will be revegetated where not required for permanent infrastructure or management access with consideration for operational safety requirements.</li> <li>Areas cleared for the Proposal within the riparian zone of Bennett Brook not required for permanent infrastructure or ongoing management of the railway will be revegetated.</li> </ul>	Not applicable.	Permanent loss of: <ul style="list-style-type: none"> <li>10.05 ha of Banksia Woodlands of the SCP TEC and PEC.</li> <li>17.2 ha of regionally significant bushland in Bush Forever site 304 (Whiteman Park).</li> <li>1.9 ha of CCW vegetation in Completely Degraded or better condition, of which 1.62 ha is located within Bush Forever site 304 (Whiteman Park).</li> <li>0.5 ha of REW 8678 vegetation in Degraded or better condition.</li> </ul>	<ul style="list-style-type: none"> <li>47.5 ha of Bush Forever site 304 (Whiteman Park) in Completely Degraded or worse condition.</li> <li>109.9 ha of vegetation in Completely Degraded or better condition, associated with REWs and Multiple Use wetlands.</li> <li>Severance of regional ecological linkages.</li> </ul>

Environmental Factor	Predicted Direct Impact(s)	Mitigation			Unacceptable significant impacts	Significant impacts that will be offset	Insignificant impacts that will not be offset
		Avoidance	Minimisation	Rehabilitation			
		<ul style="list-style-type: none"> <li>The Proposal was designed to prioritise placement within existing linear infrastructure corridors where practicable, avoiding clearing of native vegetation within the Bush Forever site 304 (Whiteman Park).</li> <li>Where possible, native vegetation within Bush Forever has been included within NVRAs to avoid clearing during construction activities</li> <li>Wherever practicable, the temporary construction footprint has been positioned to avoid clearing of native vegetation.</li> <li>Construction and operational access tracks have been designed to coincide with existing tracks or aligned along cleared areas where practicable.</li> <li>Thus far changes to the Proposal have reduced the Development Envelope from 501 ha to 463.8 ha and the Footprint from 365.9 ha to 249 ha; reducing the impacts on: <ul style="list-style-type: none"> <li>- Native vegetation from 313 ha to 152.1 ha;</li> <li>- Native vegetation by introducing 44.9 ha of NVRAs.</li> <li>- Banksia Woodlands TEC from 23.06 ha to 10.05 ha;</li> <li>- Bush Forever from 81.7 ha to 17.2 ha; and</li> <li>- Wetlands vegetation from 220.5 ha to 105.2 ha.</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Impacts to GDE have been minimised by aligning the project footprint away from native vegetation wherever practicable.</li> <li>A CEMP will be developed and maintained in accordance with current DWER guidance and policies to minimise Flora and Vegetation impacts.</li> <li>A Flora and Vegetation Management Plan will be developed and maintained to manage potential impacts to the TEC/PEC.</li> <li>Existing cleared areas will be used for temporary construction requirements, where practicable.</li> <li>Temporary clearing of Bush Forever Site 304 (Whiteman Park) will be minimised wherever practicable.</li> <li>Areas cleared for the Proposal within the riparian zone of Bennett Brook that are not required for permanent infrastructure or ongoing management of the railway will be rehabilitated.</li> </ul>				
Inland Waters	<p>Sixteen Geomorphic wetlands intersect the Footprint comprising a total area of 125.4 ha of wetland habitat that may be impacted, by the Proposal, including:</p> <ul style="list-style-type: none"> <li>Nine multiple use wetlands (MUW) – 63.1 ha intersects the Footprint;</li> <li>Four REWs – 60.4 ha intersects the Footprint; and</li> </ul>	<ul style="list-style-type: none"> <li>The Proposal has been designed to avoid clearing of CCW in Good – Degraded condition wherever practicable.</li> <li>The Proposal was designed to ensure CCW UFI 8724 (Horse Swamp) was outside the Development Envelope.</li> </ul>	<ul style="list-style-type: none"> <li>The Development Envelope and the Footprint have been amended to minimise impacts on several CCWs along the alignment.</li> <li>Impacts to Bennett Brook have been minimised by minimising the width at which the Development Envelope intersects Bennett Brook.</li> </ul>	<ul style="list-style-type: none"> <li>If required, surface water deemed to be contaminated will be remediated in accordance with the CEMP.</li> </ul>	Not applicable	<p>Impacts to:</p> <ul style="list-style-type: none"> <li>1.9 ha of CCWs comprised: <ul style="list-style-type: none"> <li>- 0.1 ha of UFI 8429 comprised of vegetation in Degraded condition located north of the proposed Malaga Station site.</li> </ul> </li> </ul>	<p>Impacts to the following wetlands located outside the Footprint, intersecting the Development Envelope:</p> <ul style="list-style-type: none"> <li>CCW UFI 8417 (within a NVRA and will not be directly impacted).</li> </ul>

Environmental Factor	Predicted Direct Impact(s)	Mitigation			Unacceptable significant impacts	Significant impacts that will be offset	Insignificant impacts that will not be offset
		Avoidance	Minimisation	Rehabilitation			
	<ul style="list-style-type: none"> <li>Three CCWs – 1.9 ha intersects the Footprint.</li> </ul>	<ul style="list-style-type: none"> <li>Establishment of NVRAs within the Development Envelope to reduce the impacts on native vegetation and avoid clearing CCWs, including UFI 8417.</li> <li>The PTA will further investigate avoiding areas of CCWs during the detailed design phase, where practicable.</li> <li>Avoidance of dewatering during construction, where practicable and consistent with construction requirements, will continue to be investigated through the development of design and construction methods.</li> <li>Impacts will be avoided as much as practicable by placing the bores away from sensitive receptors.</li> <li>Where practicable, the design will remain above the water table.</li> <li>No chemicals and/or fuel will be stored or transferred within: <ul style="list-style-type: none"> <li>DPWSA P1 or wellhead protection zones;</li> <li>the Gnamara UWPCA in the northern portion of the Development Envelope; or</li> <li>50 m of existing waterways or wetlands.</li> </ul> </li> <li>Where practicable, construction chemicals that are biodegradable and/or less hazardous will be used.</li> </ul>	<ul style="list-style-type: none"> <li>A CEMP and Acid Sulfate Soil (ASS) Management Plan will be developed in accordance with current DWER guidance and policies to: <ul style="list-style-type: none"> <li>minimise abstraction impacts to groundwater and surface water;</li> <li>minimise impacts associated with drawdown effects on ASS including the potential oxidation of ASS in or near wetlands;</li> <li>include engineering controls and/or reinjection bores or recharge basins where practicable to minimise impacts from aquifer reinjection; and</li> <li>manage chemical and fuel storage and use.</li> </ul> </li> <li>Groundwater will be extracted in accordance with a <i>Rights in Water and Irrigation Act 1914</i> Section 5C licence to minimise potential impacts to environmental values including groundwater dependent vegetation.</li> <li>Impacts from overland railway embankments will be minimised by designing them to include (where necessary) under-drainage and/or surface drainage to minimise the change.</li> <li>Detailed drainage design will incorporate management measures to avoid impacts to water course/stream bed/drainage/flow and the management of runoff and turbidity.</li> <li>Bennett Brook Bridge will be engineered to avoid as far as practicable impacts and disturbance to the water course.</li> <li>Water Sensitive Urban Design principles will be incorporated into the stormwater drainage design where feasible to:</li> </ul>			<ul style="list-style-type: none"> <li>1.2 ha of CCW UFI 8728 comprised of vegetation in Degraded to Completely Degraded condition located to the north of the future Bennett Springs East Station.</li> <li>0.6 ha of CCW UFI 15259 comprised of vegetation in Good to Completely Degraded condition located to the north of the proposed future Bennett Springs East Station.</li> <li>0.5 ha of REW UFI 8678 comprised of vegetation in Excellent to Degraded condition located north of the proposed Whiteman Park Station.</li> </ul>	<ul style="list-style-type: none"> <li>REW UFI 8806</li> <li>REW UFI 15752</li> <li>REW UFI 15757</li> <li>MUW UFI 8663</li> <li>MUW UFI 8720</li> <li>MUW UFI 8727</li> <li>MUW UFI 8729</li> <li>MUW UFI 13396</li> <li>MUW UFI 15029</li> <li>MUW UFI 15200</li> <li>MUW UFI 15511</li> <li>MUW UFI 15751</li> </ul>

Environmental Factor	Predicted Direct Impact(s)	Mitigation			Unacceptable significant impacts	Significant impacts that will be offset	Insignificant impacts that will not be offset
		Avoidance	Minimisation	Rehabilitation			
			<ul style="list-style-type: none"> <li>- Manage the first 15 mm of rainfall at-source as much as practicable.</li> <li>- Minimise the volume of water directed to large drainage basins by maximising infiltration at source within the railway corridor open drains and installing smaller detention/infiltration areas where applicable.</li> </ul>				
Terrestrial Fauna	<p>Clearing of up to:</p> <ul style="list-style-type: none"> <li>• 43 ha of fauna habitat within the Footprint including: <ul style="list-style-type: none"> <li>- 21 ha of Moderate value habitat; and</li> <li>- 22 ha of Low value habitat.</li> </ul> </li> <li>• 81.4 ha of Black Cockatoo foraging habitat including: <ul style="list-style-type: none"> <li>- 42.8 ha of High quality habitat;</li> <li>- 11.3 ha of Moderate quality habitat; and</li> <li>- 27.3 ha of Low quality habitat.</li> </ul> </li> <li>• 68.1 ha of Forest Red-tailed Black Cockatoo foraging habitat comprised of: <ul style="list-style-type: none"> <li>- 33.6 ha High quality habitat;</li> <li>- 4.3 ha of Moderate quality habitat; and</li> <li>- 30.15 ha of Low quality habitat.</li> </ul> </li> <li>• 81.4 ha Baudin's Cockatoo foraging habitat comprised of: <ul style="list-style-type: none"> <li>- 42.8 ha of Moderate quality habitat; and</li> <li>- 38.6 ha of Low quality habitat.</li> </ul> </li> <li>• 423 Black Cockatoo potential breeding trees (trees with Diameter Breast Height (DBH)&gt;500mm); 33 with (unsuitable) hollows.</li> </ul>	<ul style="list-style-type: none"> <li>• The Proposal was designed to prioritise placement within existing linear infrastructure corridors where practicable, to avoid clearing of vegetation and fauna habitat.</li> <li>• For the northern portion of the Development Envelope, the PTA aligned the rail corridor adjacent to Drumpellier Drive, near existing cleared road infrastructure along the eastern boundary of Whiteman Park to reduce fauna habitat disturbance and avoid fragmenting areas of high value fauna habitat.</li> <li>• To the south of the Development Envelope, the PTA has largely avoided high value fauna habitat by aligning the rail corridor through the largely cleared Marshall Paddocks.</li> <li>• Iterative changes to the Development Envelope have avoided impacts to wetland habitats, including a 50 m precautionary buffer from the maximum known extent of Horse Swamp.</li> <li>• The Development Envelope has been modified to avoid Black Cockatoo potential breeding trees and foraging habitat.</li> </ul>	<ul style="list-style-type: none"> <li>• The Proposal was designed to prioritise placement within low value fauna habitat areas where possible to minimise impacts to fauna habitat. More than 75% of the Development Envelope is comprised of cleared land or low value fauna habitat.</li> <li>• The Proposal was designed to place the temporary construction areas within existing cleared or Completely Degraded areas adjacent or near to the rail corridors where practicable, to minimise vegetation clearing and impacts to fauna habitat.</li> <li>• A CEMP will be developed and implemented during construction and includes mitigation and management measures.</li> <li>• Black Cockatoo potential breeding trees will be inspected prior to clearing and any trees with active nests will be temporarily protected, including a 10 m buffer.</li> <li>• Provision of a fauna crossing at Bennett Bridge and the provision of a second fauna crossing between Bennet Brook and Beechboro Road North.</li> <li>• Detailed drainage design will incorporate management measures to avoid impacts to water course/stream bed/drainage/flow and the management of runoff and turbidity.</li> </ul>	<ul style="list-style-type: none"> <li>• Areas cleared for the Proposal not required for future infrastructure or management access will be rehabilitated with consideration for operational safety requirements.</li> <li>• Disturbed and cleared riparian vegetation at Bennett Brook which was cleared for temporary construction areas will be rehabilitated.</li> </ul>	Not applicable.	<p>Clearing of up to:</p> <ul style="list-style-type: none"> <li>• 81.4 ha of Black Cockatoo foraging habitat including: <ul style="list-style-type: none"> <li>- 42.8 ha of High quality habitat;</li> <li>- 11.3 ha of Moderate quality habitat; and</li> <li>- 27.3 ha of Low quality habitat.</li> </ul> </li> <li>• 68.1 ha of Forest Red-tailed Black Cockatoo foraging habitat comprised of: <ul style="list-style-type: none"> <li>- 33.6 ha High quality habitat;</li> <li>- 4.3 ha of Moderate quality habitat; and</li> <li>- 30.15 ha of Low quality habitat.</li> </ul> </li> <li>• 81.4 ha Baudin's Cockatoo foraging habitat comprised of: <ul style="list-style-type: none"> <li>- 42.8 ha of Moderate quality habitat; and</li> <li>- 38.6 ha of Low quality habitat.</li> </ul> </li> <li>• 423 Black Cockatoo potential breeding trees (trees with DBH&gt;500mm); 33 with (unsuitable) hollows.</li> </ul>	<p>Clearing of up to:</p> <ul style="list-style-type: none"> <li>• 43 ha of fauna habitat within the Footprint including: <ul style="list-style-type: none"> <li>- 21 ha of Moderate value habitat; and</li> <li>- 22 ha of Low value habitat.</li> </ul> </li> </ul>

Environmental Factor	Predicted Direct Impact(s)	Mitigation			Unacceptable significant impacts	Significant impacts that will be offset	Insignificant impacts that will not be offset
		Avoidance	Minimisation	Rehabilitation			
		<ul style="list-style-type: none"> <li>NVRAs have avoided clearing approximately 44.5 ha of high value fauna habitat within the Development Envelope, including 25.6 ha of Black Cockatoo foraging habitat.</li> <li>NVRAs have avoided clearing approximately 201 Black Cockatoo potential breeding trees within the Development Envelope.</li> <li>An NVRA has included CCW UFI 8417, avoiding clearing 0.7 ha of this wetland.</li> <li>The Proposal has been designed to place temporary construction areas within existing cleared or Completely Degraded areas adjacent or near to the rail corridors where practicable, to minimise clearing of terrestrial fauna habitat.</li> <li>The PTA will further investigate avoiding areas of fauna habitat during the detailed design phase, where practicable.</li> <li>Water sensitive urban design principles will be implemented as part of detailed drainage design. This will include infiltration of stormwater as a preference to reduce incidence of pooling of water on the surface which may act as an attractant for fauna species such as black cockatoos and place them at increased risk of being struck by a passenger train.</li> <li>The Proposed Action includes high fencing to deter Black Cockatoos from entering the rail corridor.</li> <li>No Black Cockatoo foraging species will be planted near the train corridor for landscaping to deter use of these areas by Black Cockatoos.</li> </ul>	<ul style="list-style-type: none"> <li>Construction of Bennett Brook Bridge will be planned and undertaken in a manner that manages and avoids impacts to the water course and water quality, with particular consideration of Carter's Freshwater Mussels.</li> <li>Provision of transverse drainage design, to maintain fish passage movement (particularly the Black-stripe Minnow) through the drainage network/impacted drainage and wetland area.</li> </ul>				

## **Appendix B - Lowlands and Keysbrook Certificates of Title**



REGISTER NUMBER <b>301/DP77559</b>	
DUPLICATE EDITION <b>N/A</b>	DATE DUPLICATE ISSUED <b>N/A</b>

VOLUME **LR3164** FOLIO **969**

**RECORD OF CERTIFICATE  
OF  
CROWN LAND TITLE**  
UNDER THE TRANSFER OF LAND ACT 1893  
AND THE LAND ADMINISTRATION ACT 1997  
**NO DUPLICATE CREATED**

The undermentioned land is Crown land in the name of the STATE OF WESTERN AUSTRALIA, subject to the interests and Status Orders shown in the first schedule which are in turn subject to the limitations, interests, encumbrances and notifications shown in the second schedule.



REGISTRAR OF TITLES

**LAND DESCRIPTION:**

LOT 301 ON DEPOSITED PLAN 77559

**STATUS ORDER AND PRIMARY INTEREST HOLDER:  
(FIRST SCHEDULE)**

**STATUS ORDER/INTEREST:** RESERVE UNDER MANAGEMENT ORDER

**PRIMARY INTEREST HOLDER:** CONSERVATION COMMISSION OF WESTERN AUSTRALIA OF CARE OF DEPARTMENT OF PARKS AND WILDLIFE OF LOCKED BAG 104, BENTLEY DELIVERY CENTRE

(XE M845092 ) REGISTERED 26/3/2015

**LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:  
(SECOND SCHEDULE)**

- EASEMENT BENEFIT CREATED UNDER SECTION 136C T.L.A. FOR RIGHT OF CARRIAGEWAY PURPOSES - SEE DEPOSITED PLAN 77559.
- F854772 EASEMENT TO ELECTRICITY CORPORATION. SEE SKETCH ON DEPOSITED PLAN 77559. REGISTERED 13/4/1995.
- M950769 CLASS A RESERVE 51784 FOR THE PURPOSE OF CONSERVATION OF FLORA AND FAUNA LIMITED TO A DEPTH OF 200 METRES FROM THE NATURAL SURFACE. REGISTERED 26/3/2015.  
M845092 MANAGEMENT ORDER. CONTAINS CONDITIONS TO BE OBSERVED. REGISTERED 26/3/2015.

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required. Lot as described in the land description may be a lot or location.

-----END OF CERTIFICATE OF CROWN LAND TITLE-----

**STATEMENTS:**

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

END OF PAGE 1 - CONTINUED OVER

ORIGINAL CERTIFICATE OF CROWN LAND TITLE

REGISTER NUMBER: 301/DP77559

VOLUME/FOLIO: LR3164-969

PAGE 2

SKETCH OF LAND:

DP77559

PREVIOUS TITLE:

1089-276, 2040-535

PROPERTY STREET ADDRESS:

NO STREET ADDRESS INFORMATION AVAILABLE.

LOCAL GOVERNMENT AUTHORITY:

SHIRE OF SERPENTINE-JARRAHDALE

RESPONSIBLE AGENCY:

DEPARTMENT OF BIODIVERSITY, CONSERVATION AND  
ATTRACTIONS (SCLM)

NOTE 1: M950769 CORRESPONDENCE FILE 00013-2014-01RO

REGISTER NUMBER <b>77/P739</b>	
DUPLICATE EDITION <b>2</b>	DATE DUPLICATE ISSUED <b>21/6/2018</b>

**RECORD OF CERTIFICATE OF TITLE**  
UNDER THE TRANSFER OF LAND ACT 1893

VOLUME **1191** FOLIO **779**

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and notifications shown in the second schedule.

  
REGISTRAR OF TITLES 

**LAND DESCRIPTION:**

LOT 77 ON PLAN 739

**REGISTERED PROPRIETOR:**  
(FIRST SCHEDULE)

WESTERN AUSTRALIAN PLANNING COMMISSION OF 140 WILLIAMS STREET PERTH  
(T N924580 ) REGISTERED 20/6/2018

**LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:**  
(SECOND SCHEDULE)

1. TITLE EXCLUDES THE LAND SHOWN ON O.P. 7738.

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.  
\* Any entries preceded by an asterisk may not appear on the current edition of the duplicate certificate of title.  
Lot as described in the land description may be a lot or location.

-----END OF CERTIFICATE OF TITLE-----

**STATEMENTS:**

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND: 1191-779 (77/P739)  
PREVIOUS TITLE: 1046-383  
PROPERTY STREET ADDRESS: 671 YANGEDI RD, KEYSBROOK.  
LOCAL GOVERNMENT AUTHORITY: SHIRE OF SERPENTINE-JARRAHDAL  
RESPONSIBLE AGENCY: WESTERN AUSTRALIAN PLANNING COMMISSION

# Appendix C - Lowlands Environmental Values Assessment Report



**Public Transport Authority**  
METRONET Potential Offset Sites  
Lowlands Environmental Values Assessment

February 2020

# Executive summary

METRONET is the State government's program of projects to increase the size of Perth's railway network, whilst also supporting the planning of integrated station precincts, to support growth of the Perth metropolitan region.

Where required, METRONET projects will be assessed by the Environmental Protection Authority (EPA) under Section 38 of the *Environmental Protection Act 1986* (EP Act) and/or by the Commonwealth Department of the Environment and Energy (DEE) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

As part of the State and Federal environmental approvals processes, the Public Transport Authority (PTA) is required to offset significant residual environmental impacts of assessed projects through the implementation of an Offsets Strategy. Through liaison with other State government agencies, a number of potential offset sites have been identified containing suitable environmental values to offset the potential METRONET project impacts.

GHD Pty Ltd (GHD) was engaged by the PTA to undertake Environmental Values Assessments (EVAs) for six potential offset sites. The purpose of the EVAs is to identify the key environmental values of each site, as well as opportunities for on-ground management works to enable an assessment of their suitability as land acquisition offset sites. This report presents an EVA of a potential offset site located in Mardella, Western Australia.

The potential offset site (the survey area) is approximately 1,140 hectares (ha) and is located at Lot 301 Lowlands Road in the suburb of Mardella within the Shire of Serpentine-Jarrahdale.

## **Key findings for vegetation**

Ten broad vegetation types as well as dirt tracks were mapped by GHD within the survey area. Nine of the vegetation types were represented by remnant native vegetation, the eighth vegetation type, scattered natives over weeds, describes highly modified vegetation that has been altered by partial clearing, dieback and weeds.

The vegetation types were split into four upland vegetation types that predominately occurred on Bassendean sands and five lower lying vegetation types were mapped primarily on Pinjarra Plain soils. The vegetation types are considered to be representative of the Southern River, Guilford and Bassendean Complex-Central and South Complexes and Floristic Community Types (FTCs) 4, 5, 11, 21a, 21c, 22 and 23a.

The vegetation condition ranged from Excellent to Degraded across the survey area. Areas mapped in Degraded condition have been historically cleared/partially cleared to support grazing by livestock. Whilst there is no grazing of domestic animals today, native species such as kangaroos maintain grazing at a high level and contribute to weed spread (as well as keeping weed loads low). Dieback is present at localised spots throughout the survey area and has contributed to a decline in vegetation condition.

Based on the results of the desktop searches, previous literature, dominant species present, landform features and field observations, four conservation significant ecological communities were considered likely to occur within the survey area:

- *Banksia* woodlands of the Swan Coastal Plain, listed as a Threatened Ecological Community (TEC) under the EPBC Act.
- Low lying *Banksia attenuata* woodlands or shrublands (SCP21c), listed as a Priority 3 Priority Ecological Community (PEC) by the Department of Biodiversity, Conservation and Attractions (DBCA)

- *Banksia* dominated woodlands of the SCP IBRA region, listed as a Priority 3 PEC by the DBCA
- Tuart (*Eucalyptus gomphocephala*) woodlands of the SCP PEC, listed as a Priority 3 PEC by the DBCA.

### **Key findings for fauna and black cockatoos**

Four broad fauna habitats were described within the survey area based on the mapped vegetation types, including Mixed Eucalyptus Banksia woodland, Flooded Gum Melaleuca woodlands, Riparian and pasture with scattered trees.

The survey area is an intact area of native vegetation mostly surrounded by cleared land with low density semi-rural residential properties and has limited connectivity to other areas of bushland. The Serpentine River intersects the central part of the survey area and there is some connectivity along this river.

During the one day field visit, Carnaby's Cockatoos were seen and heard calling over the survey area. Forest Red-tailed Black Cockatoos were also observed feeding at two locations during the subsequent two day field assessment. Foraging evidence (chewed Marri, Jarrah, Banksia and Allocasuarina nuts) was recorded extensively throughout the Mixed Eucalyptus Banksia and Scattered native tree habitat types with both Carnaby's Cockatoo and Forest Red-tailed Black Cockatoo distinctive mandible marks evident. The survey area contains suitable foraging and potential breeding habitat for both Carnaby's Cockatoo and Forest Red-tailed Black Cockatoo. No foraging evidence of Baudin's Cockatoo was located within the survey area, however the survey area is considered to contain suitable foraging and potential roosting habitat.

Other conservation significant fauna recorded from the site include Chuditch, Rakali, Pouched lamprey, Carter's Freshwater Mussel, Quenda and South-western Brush-tailed Phascogale.

This report is subject to, and must be read in conjunction with, the limitations set out in section 1.5 and the assumptions and qualifications contained throughout the Report.

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Appendix B – Desktop searches

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Appendix D – Fauna data

# 1. Introduction

## 1.1 Background

METRONET is the State government's program of projects to increase the size of Perth's railway network, whilst also supporting the planning of integrated station precincts, to support growth of the Perth metropolitan region.

METRONET projects will be assessed by the Environmental Protection Authority (EPA) under Section 38 of the *Environmental Protection Act 1986* (EP Act) and/or by the Commonwealth Department of the Environment and Energy (DEE) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) where required.

As part of the State and Federal environmental approvals processes, the Public Transport Authority (PTA) is required to offset significant residual environmental impacts of assessed projects through the implementation of an Offsets Strategy. Through liaison with other State government agencies, a number of potential offset sites have been identified containing suitable environmental values to offset the potential METRONET project impacts.

## 1.2 Purpose of this report

GHD Pty Ltd (GHD) was engaged by the PTA to undertake Environmental Values Assessments (EVAs) for a number of potential offset sites. The purpose of the EVAs are to identify the key environmental values of each site, as well as opportunities for on-ground management works to enable an assessment of their suitability as land acquisition offset sites. This report presents an EVA of a potential offset site located in Mardella, Western Australia.

## 1.3 Location

The potential offset site (the survey area) is located at Lot 301 Lowlands Road in the suburb of Mardella within the Shire of Serpentine-Jarrahdale Local Government Area (LGA). The survey area covers 1,139 hectares (ha) and is mapped in Figure 1, Appendix A

The survey area is part of the Department of Biodiversity, Conservation and Attractions (DBCA) managed Lowlands Nature Reserve (also known as Lowlands), which includes Lots 300 and 301 Lowlands Road.

## 1.4 Scope of works

The scope of works for this EVA includes:

- A desktop review of existing information relating to the survey area
- A one-day site visit to confirm access requirements, hygiene protocols and to meet with relevant stakeholders
- A two day reconnaissance vegetation and fauna survey with targeted assessment of values requiring offset
- The preparation of a report documenting the findings of the desktop assessment, anecdotal observations (from stakeholders), field survey and opportunities for on-ground management works
- The provision of all mapping and spatial data.

## **1.5 Limitations and assumptions**

This report has been prepared by GHD for PTA and may only be used and relied on by PTA for the purpose agreed between GHD and the PTA as set out in section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than PTA arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by PTA and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the access, hygiene management and the location of vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

This report has assessed the flora, vegetation and fauna values within the survey area, as shown in Figure 1, Appendix A. Should the survey area location change or be refined, further assessment may be required.

## 2. Methodology

### 2.1 Desktop assessment

A desktop assessment was undertaken to identify relevant environmental information pertaining to the survey area. The desktop assessment included a review of:

- Previous flora and fauna surveys and mapping of the survey area, including:
  - Rivers 2 Ramsar: Connecting River Corridors for Landscape Resilience at Lowlands Nature Reserve (Sheenan et al. 2017)
  - Floristics of Lowlands (Keighery et al. 1995)
  - Vegetation association, condition and known threatened flora and ecological communities mapping provided by the DBCA (updated in 2017)
- The DBCA Threatened and Priority Ecological Communities (TECs and PECs), Threatened/Priority Flora and Threatened/Priority Fauna Database Searches (5 km buffer of the survey area)
- The DBCA *NatureMap* database for conservation significant flora and fauna species previously recorded within 5 km of the survey area (DBCA 2007–) (Appendix B)
- Regional vegetation complex mapping (e.g. Heddle *et al.* 1980, Webb *et al.* 2016)
- Bush Forever (Government of Western Australia (GoWA) 2000)
- Aerial imagery of the survey area.

### 2.2 Site visit and field survey

GHD ecologists completed a one day site visit on 26 June 2019. The purpose of the site visit was to meet with representatives from the DBCA, Shire of Jarrahdale Serpentine and landowners to discuss access, hygiene protocols and the biological values of survey area. During the site visit, GHD ecologists accessed the survey area via Lowlands Roads (accompanied by the DBCA) and the southern part of a north-south orientated track. From these roads/tracks limited observations on the vegetation and fauna habitat were recorded. All other access throughout the survey area was restricted due to the wet soil conditions and subsequent dieback risk at the time of the visit.

GHD ecologists completed a two day field survey of the survey area on 6 and 7 November 2019. The survey was completed in November due to rainfall across the survey area during winter and early spring that restricted access due to hygiene and dieback risk. The survey was completed in November during dry soil conditions in line with DBCA stipulated access requirements.

#### 2.2.1 Vegetation and flora

The vegetation and flora component of the field survey was a reconnaissance level and was undertaken to verify the information obtained from the desktop assessment and assess and characterise the broad vegetation types and vegetation condition throughout the survey area. Preliminary assessment of occurrence and approximate extent of potential TEC/PECs (including indicative floristic community types (FCTs)) was also completed.

Field survey methods involved a combination of sampling relevés located in identified vegetation units and traversing the survey area by vehicle and foot. The survey methodology was undertaken with reference to the EPA Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016a).

## Broad vegetation types

Broad vegetation types were identified and boundaries delineated using a combination of aerial photography, topographical features, field data/observations and mapping from Keighery *et al.* (1995) and the DBCA (2017). Data recorded at relevé sites included dominant flora taxa from each structural layer (i.e. upper, mid and ground) as well as other observable flora taxa (to assist with FCT identification); full floristics at each relevé site were not recorded. Vegetation data recorded from the survey area is provided in Appendix C.

The vegetation types were described based on structure, dominant taxa and cover characteristics. The broad vegetation type description is consistent with National Vegetation Information System (NVIS) Level IV or V, where the dominant species for the three traditional strata (upper, mid and ground) are used to describe the association (NVIS Technical Working Group 2017).

## Vegetation condition

The vegetation condition mapping from Keighery *et al.* (1995) and the DBCA (2017) was reviewed in the field, and where applicable updated. The vegetation condition was mapped in accordance with the vegetation condition rating scale for the South West and Interzone Botanical Provinces of WA (devised by Keighery (1994) and adapted by EPA (2016)). The scale recognises the intactness of vegetation and consists of six rating levels. The vegetation condition rating scale is outlined in Table 1.

**Table 1** Vegetation condition rating scale

Condition	South West and Interzone Botanical Provinces description
Pristine	Pristine or nearly so, no obvious signs of damage caused by human activities since European settlement.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. Damage to trees caused by fire, the presence of non-aggressive weeds and occasional vehicle tracks.
Very Good	Vegetation structure altered, obvious signs of disturbance. Disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds at high density, partial clearing, dieback and grazing.
Completely Degraded	The structure of vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs.

## Preliminary assessment of TECs and PECs

Preliminary identification of potential TECs and PECs within the survey area was based on vegetation association and condition mapping by Keighery *et al.* (1995) and DBCA (2017). Keighery *et al.* (1995) identified floristic community types (FCTs) for the mapped vegetation associations and this information was used to identify potential TECs and PECs within the survey area.

During the field survey, areas of vegetation representative of potential TECs and PECs were visited and preliminary identification confirmed or made based on vegetation structure, typical

and common species, and observations on soils, landforms etc. Where areas of potential TECs or PECs were identified, the occurrence was noted and the approximate extent mapped using a GPS enabled handheld tablet.

### **Flora nomenclature**

Nomenclature used in this report follows that used by the WA Herbarium as reported on *FloraBase* (WA Herbarium 1998–). The conservation status of flora was compared against the current lists available on *FloraBase* and the EPBC Act Threatened species database provided by DEE (2019).

## **2.2.2 Fauna**

The fauna component of the field survey was undertaken to verify the information obtained from the desktop assessment, describe the key fauna habitat values and identify suitable habitat for conservation significant fauna species. A black cockatoo habitat assessment was also completed.

Field methodology included traversing the survey area by vehicle and foot. The survey methodology was undertaken with reference to the EPA Technical Guidance – Sampling methods for Terrestrial Vertebrate Fauna Surveys (EPA 2016b) and EPA Technical Guidance – Terrestrial Fauna Surveys (EPA 2016c).

### **Broad fauna habitats**

Broad fauna habitats were described and boundaries delineated using a combination of aerial photography, mapping from Keighery *et al.* (1995), DBCA (2017), and site visit observations. Site characteristics include vegetation type and structure, substrate, topography, and hydrology. Fauna habitats were also aligned with the vegetation types delineated during the vegetation and flora assessment of this current survey. Anecdotal observations from stakeholders were incorporated into the broad habitat type descriptions where possible.

### **Black cockatoo assessment**

A desktop black cockatoo habitat assessment was undertaken and included an evaluation of presence and approximate extent of foraging, breeding and roosting habitat within the site. Habitat suitability was based on the mapping from Keighery *et al.* (1995) and DBCA (2017), and broad fauna habitats described by GHD. Foraging, breeding and roosting habitat was defined as per the EPBC Act referral guidelines for three threatened black cockatoo species: Carnaby's Cockatoo (endangered) *Calyptorhynchus latirostris*, Baudin's Cockatoo (vulnerable) *Calyptorhynchus baudinii*, Forest Red-tailed Black Cockatoo (vulnerable) *Calyptorhynchus banksii naso*, (Department of Sustainability, Environment, Water, Populations, and Communities (DSEWPac) 2012).

A black cockatoo habitat assessment was undertaken in conjunction with the broad habitat assessment. The black cockatoo habitat assessment included:

- Evaluation of presence and approximate extent of foraging, breeding and roosting habitat (individual mapping of potential breeding tree locations was not undertaken). Foraging, breeding and roosting habitat was defined as per the EPBC Act referral guidelines for three threatened black cockatoo species: Carnaby's Cockatoo (endangered) *Calyptorhynchus latirostris*, Baudin's Cockatoo (vulnerable) *Calyptorhynchus baudinii*, Forest Red-tailed Black Cockatoo (vulnerable) *Calyptorhynchus banksii naso*, (Department of Sustainability, Environment, Water, Populations, and Communities (DSEWPac) 2012)
- Characterisation of the broadly mapped vegetation types for suitability as black cockatoo foraging, breeding and roosting habitat

- Foraging habitat values were quantified and a rating assigned based on the type, approximate and relative density and variety of known food plant species for black cockatoos.
- Potential breeding habitat values were quantified based on the density of potential breeding trees of known Black Cockatoo breeding tree species. Potential breeding tree density was calculated within a series of 50 x 50 m plots randomly located within each broad habitat type. Within each plot the Diameter at Breast Height (DBH) measured for all trees having DBH greater than 50 cm. A list of all plots and locations is included in Appendix D.
- Roosting habitat values were assessed based on presence of potentially suitable emergent tall trees, proximity of freshwater bodies, and on the local occurrence of any known roost sites (BirdLife Australia, unpublished data).
- Recording and mapping black cockatoo observations of foraging evidence, breeding and roosting activity.

### ***Fauna nomenclature***

Fauna nomenclature used in this report follows that used by the WA Museum and the DBCA *NatureMap* database (DBCA 2007–) with the exception of birds, where by Christidis and Boles (2008) was used.

## **2.3 Limitations**

### **2.3.1 Desktop limitations**

The records from the DBCA searches and *NatureMap* database provide generally accurate information for the general area. However, some records of collections, sightings or trappings cannot be dated or have plain language locality descriptions and may misrepresent the current range of a species (flora and fauna).

### **2.3.2 Field limitations**

The EPA technical guidance recommend flora and fauna survey reports for environmental impact assessment in WA should contain a section describing the limitations of the survey methods used. The limitations and constraints associated with this field component are discussed in Table 2. Based on this assessment, the field component has been subject to constraints that have affected the thoroughness of the assessment and the conclusions which have been formed.

**Table 2 Field limitations**

Aspect	Constraint	Comment
Sources of information and availability of contextual information.	Nil	Adequate information is available for the survey area including a previous vegetation and flora survey (Keighery <i>et al.</i> 1995) and vegetation association, condition and known threatened flora and ecological communities mapping provided by the DBCA (2017).
Scope (what life forms were sampled etc.)	Nil	Vascular flora and terrestrial vertebrate fauna were sampled during the survey. Non-vascular flora, invertebrate and aquatic fauna were not surveyed. This survey focused on dominant flora and conservation significant fauna species.
Proportion of flora collected and identified (based on sampling, timing and intensity) Proportion of fauna identified, recorded and/or collected	Nil	The reconnaissance vegetation survey was undertaken in November, which is within the recommended timing for flora surveys in the South West Botanical Province (September – November) (EPA (2016a)). The vegetation survey was focused on describing broad vegetation types and their condition. The survey timing was considered appropriate for the purpose of the assessment. The reconnaissance fauna survey was also undertaken in November 2019. The fauna assessment sampled those species that can be easily seen, heard or have distinctive signs, such as tracks, scats, diggings, etc. Many cryptic species would not have been identified during a reconnaissance survey and seasonal variation within species often requires targeted surveys at a particular time of the year. Of the fauna species recorded during the survey, all were identified to species level. The fauna assessment was aimed at identifying broad habitat types and conservation significant terrestrial vertebrate fauna utilising the survey area. The survey timing was considered appropriate for the purpose of the assessment
Flora determination	Minor	Flora determination was undertaken by the GHD botanist in the field and at the WA Herbarium. Two taxa could only be identified to family level only, eight taxa could be identified to genus level only, and three taxa could be tentatively identified to species level, due to lack of flowering and/or fruiting material required for identification. The collecting and identification of flora taxa was considered appropriate for the purpose of the assessment.
Completeness and further work which might be needed (e.g. was the relevant area fully surveyed)	Nil	The survey area was accessible via vehicle and foot (during dry soil conditions). All areas of the survey area were adequately surveyed for the purpose of the assessment.
Mapping reliability	Minor	The vegetation was mapped using high-resolution ESRI aerial imagery obtained from Landgate, topographical features, previous broad scale mapping (Keighery <i>et al.</i> (1995), (DBCA (2017)) and field data. Data was recorded in the field using hand-held GPS tools (e.g. Samsung tablet and Garmin GPS). Certain atmospheric factors and other sources of error can affect the accuracy of GPS receivers. The Garmin GPS units used for this survey are accurate to within $\pm 5$ metres on average. Therefore the data points consisting of coordinates recorded from the GPS may contain inaccuracies.
Timing/weather/season/cycle	Nil	The field survey was conducted on 6 and 7 November 2019. In the three months prior to the flora survey (August to October), Serpentine weather station (Bureau of Meteorology (BoM) 2019) recorded a total of 208.8 mm of

Aspect	Constraint	Comment
		rainfall. This rainfall total is slightly lower than the long term average for the same period (August - October 285.4 mm) (BoM 2019). The weather conditions recorded during the survey are within the observed climatic conditions previously recorded for November 2019 (years 1899 to 2019) at the Serpentine weather station (BoM 2019). The weather conditions recorded during the survey were considered unlikely to have impacted the survey results. The survey timings were considered appropriate for the field survey.
Disturbances (e.g. fire, flood, accidental human intervention)	Nil	No significant sources of disturbance were present during the survey. There was no recent evidence of fire or flood throughout the survey area
Intensity (in retrospect, was the intensity adequate)	Nil	The survey area was sufficiently covered by the survey team during the survey. The purpose of the survey was a reconnaissance level survey with a focus on conservation significant vegetation and fauna. The survey intensity was sufficient for the survey purpose.
Resources	Nil	Adequate resources were employed during the field survey. Four person days were spent undertaking the survey using suitably qualified personnel.
Access restrictions	Minor	Access was restricted to the survey area during wet soil conditions. No access problems were encountered during the November survey which occurred during dry soils conditions.
Experience levels	Nil	The botanist and zoologist who executed the survey are practitioners suitably qualified and experienced in their respective fields. Botanist Angela Benkovic has over 13 years' experience in undertaking flora and vegetation surveys within WA. Zoologist Robert Browne-Cooper has over 15 years' experience undertaking fauna surveys in WA.

## 3. Desktop assessment

### 3.1 Literature review

A floristic assessment by Keighery et al. (1995) has been completed at Lowlands, which reported on environmental features, vegetation and flora. Mapping from this assessment has been reviewed and updated by the DBCA to provide maps of the vegetation associations, condition and conservation significant vegetation and flora (DBCA 2017). In addition an article produced by Sheenan et al. (2017) (from the Department of Parks and Wildlife, DPaW – now the DBCA) details the management works being undertaken at Lowlands as part of the Rivers 2 Ramsar: Connecting River Corridors for Landscape Resilience Project.

A summary of the results from Keighery et al. (1995) and Sheenan et al. (2017), as well as background on the Lowlands site compiled by the PTA is provided below.

#### *Lowlands site background (provided by the PTA)*

In 2014, Lots 300 and 301 Lowlands Road Mardella were purchased by the Western Australian Planning Commission (WAPC) through funding provided by both the WAPC and Main Roads Western Australia (Main Roads). The lots were purchased for the purposes of using the site to offset impacts from future government projects.

Lot 300 Lowlands Road Mardella was applied to Main Roads Gateway project in 2015. In 2015, initiated by the Main Roads Gateway project offset, both lots were ceded to the then DPaW, now DBCA for conservation and proposed protection as an 'A' Class conservation reserve. Lowlands Class 'A' conservation reserve status was also applied for urgent management reasons and to honour the agreement made with the former landowner.

In 2019, the balance of Lowlands, i.e. the entirety of Lot 301 Lowlands Road Mardella, 1,138 ha, was allocated to METRONET. Allocation of the remainder of Lowlands to offset residual significant environmental impacts of METRONET rail infrastructure projects aligns with the original intention and proposed future use of Lowlands as a State Government advanced offset, as agreed to in principle by the State and Commonwealth.

#### *Floristics of Lowlands (Keighery et al. 1995)*

The survey work at Lowlands covered two areas, Lot 300 and the Lot 301 and was completed over three flowering seasons in 1992, 1993 and 1994. Twenty-three 100 m<sup>2</sup> sites were used to sample the range of plant communities within the Lowlands with a further two sites located in the unmade road reserve south of Lowlands. Of the 25 sites, 23 were permanently located using steel pegs to enable resampling. Opportunistic plant collections were made during foot and vehicular transects of the bushland areas at various times of the three years of survey. It was considered that approximately 95% of the flora within Lowlands has been documented.

Nine vegetation associations were mapped by Keighery et al. (1995) which could be grouped into three broad units:

- *Banksia* Woodlands
  - *Banksia* Woodlands to Forests with scattered emergent eucalypts (ebW)
  - *Banksia*, Sheoak (*Allocasuarina fraseriana*) and/or Paperbark (*Melaleuca preissiana*) Woodlands to Forests (baW and bmW)

- Tuart Woodland (tW)
- *Jacksonia sternbergiana* Low Woodland (jLW)
- *Banksia* Woodland or scattered *Banksia* over Spearwood (*Kunzea ericifolia*) Closed Tall Shrubland (bkW)
- Ephemeral Wetlands
  - Freshwater Paperback (*Melaleuca raphiophylla*) Woodland to Shrubland (mrW)
  - Woodlands over Sedgeland (WS)
  - Claypans
  - Other Sumplands
- River – Creekline
  - Flooded Gum (*Eucalyptus rudis*) Forest to Woodland (rF).

The mapped vegetation associations were broadly related to floristic units mapped by Gibson et al. (1994) including 21a, 23a, 21c, 5, 11 and 4.

Keighery et al. (1995) reported that the majority of native vegetation at Lowlands was in Very Good to Good condition. There is considerable disturbance associated with the transitional areas between the pasture and the bushland. The most severe weed invasion is associated with wetland areas.

The survey recorded 438 flora taxa, of which 334 were native taxa and 104 were introduced (exotic) taxa. The most species diverse families included Orchidaceae (33 taxa), Cyperaceae (23 taxa) and Myrtaceae (22 taxa). Seven conservation or other significant flora taxa were recorded from Lowlands, these included *Caladenia huegelii* (Threatened), *Drakaea elastica* (Threatened), *Eryngium pinnatifidum* subsp. Palustre (G.J. Keighery 13459) (Priority 3), *Parsonsia diaphanophleba* (Priority 4), *Conostephium minus* (now delisted), *Stylidium longitubum* (Priority 4) and *Stylidium mimeticum* (now *S. calcaratum* and not listed). Other significant taxa recorded during the survey included: *Dillwynia dillwynioides* (now Priority 3), *Gnephosis angianthoides*, *Lagenophora huegelii*, *Johnsonia* aff. *pubescens* and *Eucalyptus gomphocephala*.

The assessment by Keighery et al. (1995) concluded that the bushland at Lowlands is of very high conservation value as it contains mature *Banksia* Woodlands, has a diversity of floristic community types (FCTs) in a unique combination, contains significant areas of *Banksia* Woodland FCTs 21a and 21c, is a rare example of intact riverine communities, and contains populations of conservation and other significant flora.

### ***Rivers 2 Ramsar; Connecting River Corridors for Landscape Resilience at Lowlands Nature Reserve (Sheenan et al. 2017)***

The DBCA has managed Lowlands (Lot 300 and 301) since 2015, which contains 1,310 ha of intact remnant bushland and a portion of the Serpentine River. According to Sheen et al. (2017), threats to Lowlands include Phytophthora dieback, altered hydrological regimes on the riverine system, introduced weeds, invasive animal species, unmanaged access and potential impacts of wildfire. Therefore on ground works at Lowlands for the Rivers 2 Ramsar: Connecting River Corridors for Landscape Resilience Project have focused on dieback mapping and control, weed and feral animal control, revegetation, fencing and collection and establishment of a seedbank for the reserve.

Sheen et al. (2017) reports that Lowlands contains significant areas of mature *Banksia* woodland as well as wetland vegetation. The wetland vegetation along the Serpentine River comprises herblands, sedgeland and shrublands and contains flora rarely found on the Swan Coastal Plain (SCP) including Lowlands creeper (*Parsonsia*

*diaphanophleba*) and Maidenhair fern (*Adiantum aethiopicum*). Weed mapping and control has focused on infestations along the Serpentine River and within revegetation sites targeting Arum lily (*Zantedeschia aethiopica*), Blackberry (*Rubus fruticosus*), Bridal creeper (*Asparagus asparagoides*), Cotton bush (*Gomphocarpus fruticosus*), Freesia (*Freesia alba x leichtinii*), Black flag (*Ferraria crispa*) and Watsonia (*Watsonia meriana*).

The riverine system at Lowlands retains a diversity of freshwater fish and provides spawning grounds for Carters freshwater mussel (*Westralunio carteri*) and Pouched lamprey (*Geotria australis*). The river also provides important habitat for threatened mammals including Rakali (*Hydromys chrysogather*) and Quenda (*Isodoodon obesulus fusciventer*). Sheen et al. (2017) reports introduced fauna including foxes and cats are a threat to native fauna at Lowlands and 1080 fox baiting has also been carried out.

Dieback interpretation shows that *Phytophthora cinnamomi* is present although most of the Reserve is dieback free. A Hygiene Management Plan has been developed and dieback vehicle wash-down bays and signage has been installed on the reserve along major access tracks.

## 3.2 Wetlands

There are eight wetlands as described by Hill et al. (1996), which are within or intersect the survey area (Table 3 and Figure 2, Appendix A). Of these, two are Conservation Category wetlands (CCWs).

**Table 3 Geomorphic wetlands within or intersecting the survey area**

Name	UFI	Classification	Evaluation
Unknown	7244	Palusplain	Resource Enhancement
Unknown	7296	Palusplain	Conservation
Unknown	14744	Sumpland	Resource Enhancement
Unknown	14749	Sumpland	Resource Enhancement
Unknown	14846	Palusplain	Resource Enhancement
Unknown	14848	Palusplain	Conservation
Unknown	15250	Palusplain	Multiple Use
Unknown	16021	Palusplain	Multiple Use

## 3.3 Land use

### 3.3.1 DBCA legislated lands

The survey area is part of a Nature Reserve (R 51784, Class A), which is known as Lowlands Nature Reserve (Figure 3, Appendix A).

### 3.3.2 Bush Forever

The majority of the survey area is covered by Bush Forever Site no. 368, Lowlands Bushland – Eastern Block Peel Estate. Bush Forever Site no. 371, Serpentine River, Peel Estate to Serpentine also intersects the eastern boundary of the survey area (Figure 3, Appendix A)

### 3.3.3 Environmentally Sensitive Areas

The majority of the survey area lies within an Environmentally Sensitive Area (ESA). This ESA likely aligns with the presence of Bush Forever sites, CCWs, TECs and their buffer zones (Figure 3, Appendix A).

### 3.4 Regional vegetation complexes

Regional vegetation has been mapped by Heddle et al. (1980) with updates from Webb et al. (2016) based on major geomorphic units on the SCP. The mapping indicates that four vegetation complexes are present within the survey area, the Dardanup Complex, the Guildford Complex, the Southern River Complex and the Bassendean Complex – Central and South (Figure 4, Appendix A). These complexes occur on the Pinjarra Plain and Bassendean Dunes landform units as well as combinations of both units. The vegetation complexes include:

- Dardanup Complex: Mosaic of vegetation types characteristic of adjacent vegetation complexes such as Serpentine River, Southern River and Guildford
- Guildford Complex: A mixture of open forest to tall open forest of *Corymbia calophylla*- *Eucalyptus wandoo* - *E. marginata* and woodland of *E. wandoo* (with rare occurrences of *E. lane-poolei*). Minor components include *E. rudis* - *Melaleuca raphiophylla*
- Southern River Complex: Open-woodland of *Corymbia calophylla*, *Eucalyptus marginata*, *Banksia* on the elevated areas and a fringing woodland of *E. rudis*, *Melaleuca raphiophylla* along the streams. South of the Murray River *Agonis flexuosa* occurs in association with the *E. rudis* and *Melaleuca raphiophylla*
- Bassendean Complex-Central and South: Vegetation ranges from woodland of *Eucalyptus marginata* - *Allocasuarina fraseriana* - *Banksia* species to low woodland of *Melaleuca* species, and sedgelands on the moister sites. This area includes the transition of *Eucalyptus marginata* to *E. todtiana* in the vicinity of Perth.

### 3.5 Conservation significant communities

A desktop search of the DBCA TEC and PEC database identified nine TECs and three PECs potentially occurring within the survey area. One additional TEC was also considered as potentially occurring within the survey area, the *Banksia* Woodlands of the SCP TEC. Details on all of these communities, based on a 5 km search buffer are provided in Table 4 and Figure 5, Appendix A.

**Table 4 TECs and PECs identified in the desktop search that may occur within the survey area**

Community	EPBC Act	BC Act/DBCA	Description
<i>Banksia</i> woodlands of the SCP TEC	Endangered		The ecological community is a woodland associated with the SCP. A key diagnostic feature is a prominent tree layer of <i>Banksia</i> , with scattered eucalypts and other tree species often present among or emerging above the <i>Banksia</i> canopy. The understorey is a species rich mix of sclerophyllous shrubs, graminoids and forbs. The ecological community is characterised by a high endemism and considerable localised variation in species composition across its range (TSSC 2016).
<i>Banksia</i> dominated woodlands of the SCP IBRA Region PEC	A component of the <i>Banksia</i> TEC	Priority 3	Canopy is most commonly dominated or co-dominated by <i>Banksia attenuata</i> and/or <i>B. menziesii</i> . Other <i>Banksia</i> species that can dominate in the community are <i>B. prionotes</i> or <i>B. ilicifolia</i> . It typically occurs on well drained, low nutrient soils on sandplain landforms, particularly deep Bassendean and Spearwood sands and occasionally on Quindalup sands; it is also common on sandy colluvium and aeolian sands of the Ridge Hill Shelf, Whicher Scarp and Dandaragan Plateau and can occur in other less common scenarios (DBCA 2019)
<i>Corymbia calophylla</i> – <i>Kingia australis</i> woodlands on heavy soils (SCP3a) TEC	Critically Endangered	Endangered	A woodland community located on heavy soils of the eastern side of the Swan Coastal Plain between Capel and Hazelmere. Typical and common native taxa in the community are: <i>Corymbia calophylla</i> ; the shrubs <i>Banksia nivea</i> , <i>Philotheca spicata</i> , <i>Kingia australis</i> and <i>Xanthorrhoea preissii</i> ; herbs, rushes and sedges, <i>Cyathochaeta avenacea</i> , <i>Dampiera linearis</i> , <i>Haemodorum laxum</i> , <i>Desmocladius fasciculatus</i> , <i>Mesomelaena tetragona</i> and <i>Tetraria octandra</i> . The introduced grass <i>Briza maxima</i> is also common in the community.
<i>Corymbia calophylla</i> - <i>Eucalyptus marginata</i> woodlands on sandy clay soils of the southern Swan Coastal Plain (SCP3b) TEC		Vulnerable	No description available.
<i>Corymbia calophylla</i> - <i>Xanthorrhoea preissii</i> woodlands and shrublands, Swan Coastal Plain (SCP3c) TEC	Critically Endangered	Endangered	The community is located on heavy soils of the eastern side of the SCP between Bullsbrook, and Waterloo near Bunbury. Dominant species in the community are the trees <i>Corymbia calophylla</i> and occasionally <i>Eucalyptus wandoo</i> ; the shrubs <i>Xanthorrhoea preissii</i> , <i>Acacia pulchella</i> , <i>Dryandra nivea</i> , <i>Gompholobium marginatum</i> , and <i>Hypocalymma angustifolia</i> and the herbs <i>Burchardia umbellata</i> , <i>Cyathochaeta avenacea</i> and <i>Neurachne alopecuroidea</i> .

Community	EPBC Act	BC Act/DBCA	Description
Communities of Tumulus Springs (Organic Mound Springs, Swan Coastal Plain) TEC		Endangered	The habitat of this community is characterised by continuous discharge of groundwater in raised areas of peat. The peat and surrounds provide a stable, permanently moist series of microhabitats. Intact vegetated tumulus springs are only found at four locations. Typical and common native vascular plant species associated with the tumulus springs are the trees <i>Banksia littoralis</i> , <i>Melaleuca preissiana</i> and <i>Eucalyptus rudis</i> , and the shrubs <i>Agonis linearifolia</i> , <i>Pteridium esculentum</i> , <i>Astartea fascicularis</i> and <i>Cyclosorus interruptus</i> .
<i>Banksia attenuata</i> and/or <i>Eucalyptus marginata</i> woodlands of the eastern side of the Swan Coastal Plain (SCP20b) TEC	Endangered	Endangered	Most of the occurrences of this community type are <i>Eucalyptus marginata</i> – <i>Banksia attenuata</i> woodlands but the community also occurs as <i>Banksia</i> woodlands and heaths. A diverse shrub layer comprising <i>Hakea stenocarpa</i> , <i>Conostylis setosa</i> , and <i>Johnsonia</i> aff. <i>pubescens</i> differentiates this community type from the other two subgroups. The community is found on a range of soils on the base of the Darling Scarp from Yarloop to Byford. Soils are mainly yellow orange and yellow sands.
Herb rich saline shrublands in clay pans (SCP07) TEC	Critically Endangered TEC (part)	Vulnerable	This vegetation community type occurs on heavy clay soils that are generally inundated from winter to mid-summer. Structurally this vegetation community type is quite variable ranging from woodlands to herblands, the most common overstorey taxa being <i>Melaleuca viminea</i> , <i>M. uncinata</i> , <i>M. cuticularis</i> or <i>Casuarina obesa</i> . Aquatic species are common in this vegetation community early in the growing season. Typical species in the understorey include the common herbs <i>Brachyscome bellidioides</i> , <i>Centrolepis polygyna</i> , <i>Pogonolepis stricta</i> and <i>Cotula coronopifolia</i> .
Herb rich shrublands in clay pans (SCP08) TEC	Critically Endangered TEC (part)	Vulnerable	Occurs in low lying flats with a clay impeding layer allowing seasonal inundation. Dominated by one or more of the shrubs: <i>Viminaria juncea</i> , <i>Melaleuca viminea</i> , <i>M. lateritia</i> , <i>Kunzea micrantha</i> or <i>K. recurva</i> with occasional emergents of <i>Eucalyptus wandoo</i> . Species such as <i>Hypocalymma angustifolium</i> , <i>Acacia lasiocarpa</i> var. <i>bracteolata</i> long peduncle variant (G. J. Keighery 5026) and <i>Verticordia huegellii</i> occur at moderate frequencies.
Dense shrublands on clay flats (SCP09) TEC	Critically Endangered TEC (part)	Vulnerable	This vegetation community type is shrublands or low open woodlands on clay flats that are inundated for long periods because it usually occurs very low in the landscape. Sedges are more apparent in this ecological community and include <i>Chorizandra enodis</i> , <i>Cyathochaeta avenacea</i> , <i>Lepidosperma longitudinale</i> and <i>Meeboldina coangustata</i> . Shrubs include <i>Hakea varia</i> and <i>Melaleuca viminea</i> and occasionally <i>Xanthorrhoea preissii</i> , <i>Xanthorrhoea drummondii</i> and <i>Kingia australis</i> .

Community	EPBC Act	BC Act/DBCA	Description
Shrublands on dry clay flats (SCP10a) TEC	Critically Endangered TEC (part)	Endangered	A distinctive feature of the particular clay pan wetlands that comprise the ecological community is the suite of geophytes and annual flora that germinates, grows and flowers sequentially as these areas dry over summer, producing a floral display for over three months. The clay pans have very high species richness, a number of local endemics and are the most floristically diverse of the SCP wetlands
Low lying <i>Banksia attenuata</i> woodlands or shrublands (SCP21c) PEC	A component of the <i>Banksia</i> TEC	Priority 3	This type occurs sporadically between Gingin and Bunbury, and is largely restricted to the Bassendean system. The type tends to occupy lower lying wetter sites and is variously dominated by <i>Melaleuca preissiana</i> , <i>Banksia attenuata</i> , <i>B. menziesii</i> , <i>Regelia ciliata</i> , <i>Eucalyptus marginata</i> or <i>Corymbia calophylla</i> . Structurally, this community type may be either a woodland or occasionally shrubland.
<i>Casuarina obesa</i> association PEC		Priority 1	Thomas Rd to Serpentine River, Swan Coastal Plain. No detailed information to assess if distinct community.

### 3.6 Conservation significant flora

The *NatureMap* database search identified the presence/potential presence of 15 conservation significant flora taxa within 5 km of the survey area. The search recorded:

- Five taxa listed under the EPBC Act and/or *Biodiversity Conservation Act 2016* (BC Act)
- One Priority 1 taxon
- One Priority 2 taxon
- Five Priority 3 taxa
- Three Priority 4 taxa.

The DBCA Threatened and Priority flora searches (TPFL and WAHERB) supplied by the PTA identified 72 records of conservation significant flora taxa within a 5 km buffer of the survey area (Figure 5, Appendix A). The DBCA database searches contained no species names or identifiers, therefore no comparisons with the *NatureMap* searches results could be made.

The DBCA database search results indicate 20 records of conservation significant flora occur within the survey area.

### 3.7 Conservation significant fauna

The *NatureMap* database search identified the presence/potential presence of nine conservation significant fauna species within 5 km of the survey area, excluding marine listed species as no marine habitat is present within the survey area. The search recorded:

- Four species listed under the EPBC Act and/or BC Act as Endangered or Vulnerable
- Four Priority 4 species
- One species of special conservation interest (conservation dependent fauna).

The DBCA Threatened and Priority fauna search supplied by the PTA identified 91 records of conservation significant fauna taxa within a 5 km buffer of the survey area (Figure 5, Appendix A). The DBCA database searches contained no species names or identifiers, therefore no comparisons with the *NatureMap* searches results could be made.

The DBCA database search results indicate six records of conservation significant fauna occur within the survey area.

#### ***Black cockatoos***

Available Carnaby's Cockatoo mapping (GoWA 2019) provides locations of confirmed and possible breeding areas, confirmed, unconfirmed and buffered roosting areas, and feed areas (as outlined by Glossop et al. (2011)). This mapping indicates the survey area contains plant species which Carnaby's cockatoos show a preference for when feeding (mapped as feed area requiring investigation). There are no confirmed breeding or roosting locations occurring within 5 km of the survey area. However, the 2018 Great Cocky Count (Peck et al. 2018) reports a confirmed roost for Carnaby's Cockatoo in the Lowlands area.

## 4. Field survey

The results presented below are collated from desktop sources, the one day site visit and two day field survey.

### 4.1 Broad vegetation types

Ten broad vegetation types as well as dirt tracks were mapped by GHD within the survey area. Nine of the vegetation types were represented by remnant native vegetation, the eighth vegetation type, scattered natives over weeds, describes highly modified vegetation that has been altered by partial clearing, dieback and weeds. Vegetation types identified within the survey area are described in Table 5 and mapped in Figure 6, Appendix A.

The vegetation types mapped by GHD refined the boundaries of the 12 vegetation associations mapped by Keighery et al. (1995) and updated by DBCA (2017). Four vegetation associations have been merged into broader vegetation types. *Amphibromus nervosus* grasslands (anG) has been merged into scattered natives over weeds because this area is now represented by isolated sedges of *Juncus pallidus* over pasture weeds. Other sumplands has been merged into the *Melaleuca* woodland vegetation type due to similar dominant upper strata species.

*Corymbia calophylla* and *Melaleuca raphiophylla* woodland and *Eucalyptus rudis* *Melaleuca* woodland have also been merged into one vegetation type due to similarities in dominant upper strata species. Conversely vegetation association *Banksia*, *Allocasuarina fraseriana* and/or *Melaleuca preissiana* Woodlands to Forests has been split into two vegetation types; *Allocasuarina Banksia* woodland and a small isolated patch of *Banksia ilicifolia* woodland. This was due to the dominance of *Banksia ilicifolia* within the area and lack of other dominant/ co dominate upper strata *Banksia* spp., the dominance of *B. ilicifolia* in this area has implications when classifying the community as a conservation significant (see further detail in section 4.3).

The vegetation within the survey area represents a unique combination of upland and lowland vegetation communities that is influenced by landform and soil types. Whilst the survey area is bordered to the east and west by Pinjarra Plain, the soils within the survey area predominately Bassendean sands (Keighery et al. 1995). The Pinjarra Plain is exposed along the Serpentine River and in the seasonally waterlogged areas to the north of the survey area. There were four upland vegetation types mapped by GHD that predominately occurred on Bassendean sands. The two dominant vegetation types were *Banksia* woodland types that represented 68 % (775.8 ha) of the survey area. The lower lying vegetation types were mapped primarily on Pinjarra Plain soils, which is where the most isolated vegetation type was mapped, Tuart woodlands 0.05 % (0.6 ha) of the survey area.

The vegetation types are considered to be representative of the Southern River, Guilford and Bassendean Complex-Central and South Complexes. Based on landforms and previous literature (e.g. Keighery et al. 1995 and Gibson et al. 1994) the vegetation types identified within the survey area are considered to align with the following FCT's:

- FCT4 – *Melaleuca preissiana* damplands
- FCT5 – Mixed shrub damplands
- FCT11 – Wet forests and woodlands
- FCT21a – Central *Banksia attenuata* – *Eucalyptus marginata* woodlands
- FCT21c – Low lying *Banksia attenuata* woodlands or shrublands
- FCT22 – *Banksia ilicifolia* woodlands
- FCT23a – Central *Banksia attenuata* – *B. menziesii* woodlands.

**Table 5 Vegetation types described within the survey area**

Vegetation type and description	Extent (ha)	FCT alignment	Photograph
<b>Upland vegetation types</b>			
<p><b><i>Eucalyptus Banksia</i> woodland (EBw)</b>  <i>Eucalyptus marginata</i> and <i>Allocasuarina fraseriana</i> isolated trees over <i>Banksia menziesii</i>, <i>B. attenuata</i> and <i>Xylomelum occidentale</i> low woodland over <i>Kunzea glabrescens</i> tall sparse shrubland over <i>Stirlingia latifolia</i>, <i>Dasypogon bromeliifolius</i> and <i>Desmocladius flexuosus</i> herbland.</p> <p>This is the most dominant vegetation type within the survey area</p>	712.6	21a and 23	
<p><b><i>Allocasuarina Banksia</i> woodland (ABw)</b>  <i>Allocasuarina fraseriana</i> and/or <i>Melaleuca preissiana</i> mid open woodland over <i>Banksia menziesii</i> and <i>B. attenuata</i> low woodland over <i>Kunzea glabrescens</i> tall shrubland over <i>Dasypogon bromeliifolius</i> and <i>Desmocladius flexuosus</i> herbland.</p> <p>Higher densities of <i>A. fraseriana</i> were recorded within this vegetation type along with occasional stands of <i>M. preissiana</i>, when compared to EBw</p>	63.2	21c	

Vegetation type and description	Extent (ha)	FCT alignment	Photograph
<p><b><i>Banksia ilicifolia</i> woodland (Biw)</b>  <i>Banksia ilicifolia</i> low woodland over <i>Xanthorrhoea preissii</i> low open shrubland over <i>Dasypogon bromeliifolius</i> and <i>Patersonia occidentalis</i> herbland</p> <p>This type was recorded from a small pocket located in the north western extent of the survey area</p>	3.3	22	
<p><b><i>Corymbia calophylla</i> open woodland (Cw)</b>  <i>Corymbia calophylla</i> tall open woodland over <i>Melaleuca preissiana</i> and/ or <i>Eucalyptus rudis</i> isolated trees over <i>Kunzea glabrescens</i> tall shrubland over weeds</p> <p>Located within the south eastern extent and part of the southern tributary of the Serpentine River.</p>	14.4	-	

Vegetation type and description	Extent (ha)	FCT alignment	Photograph
<b>Lowland vegetation types</b>			
<p><b><i>Banksia Kunzea</i> woodland (BKw)</b>  <i>Banksia attenuata</i> and <i>B. ilicifolia</i> woodland over <i>Kunzea glabrescens</i> tall shrubland over <i>Calytrix angulata</i> low open shrubland over <i>Patersonia occidentalis</i> and <i>Desmocladius flexuosus</i> open herbland.</p> <p>It should be noted that when Keighery et al. (1995) surveyed the site <i>K. glabrescens</i> had not been recognised and was considered the same as <i>K. ericifolia</i>. <i>Kunzea glabrescens</i> was identified as a new taxon separate from <i>K. ericifolia</i> by Toelken (1996). Specimens collected by GHD within the survey area were identified as <i>K. glabrescens</i>.</p>	146.9	21c	
<p><b><i>Eucalyptus Melaleuca</i> woodland (EMw)</b>  <i>Eucalyptus rudis</i> tall woodland over <i>Melaleuca preissiana</i> and <i>M. raphiophylla</i> low woodland over <i>Dielsia stenostachya</i> and <i>Juncus pallidus</i> closed sedgeland</p> <p>Mapped within the north and south western extents of the survey area</p>	19.7	4	

Vegetation type and description	Extent (ha)	FCT alignment	Photograph
<p><b><i>Eucalyptus rudis</i> forest (Ef)</b>  <i>Eucalyptus rudis</i> tall closed forest over <i>Astartea</i> sp. tall sparse shrubland over <i>Pteridium esculentum</i> closed fernland and <i>Lepidosperma longitudinale</i> open sedgeland.</p> <p>This vegetation type follows the Serpentine River. The density of <i>E. rudis</i> decreases with increasing distance from the river.</p>	36.0	11	
<p><b><i>Melaleuca</i> woodland (Mw)</b>  <i>Melaleuca preissiana</i> with occasional <i>M. raphiophylla</i> low open woodland over tall open shrubland <i>Kunzea glabrescens</i> tall open shrubland over <i>Astartea</i> sp. isolated shrubs over <i>Lyginia imberbis</i> and <i>Dasypogon bromeliifolius</i> open herbland  Mapped in areas of poor drainage within the survey area.</p>	4.8	5	

Vegetation type and description	Extent (ha)	FCT alignment	Photograph
<p><b>Tuart woodland (Tw)</b>  <i>Eucalyptus gomphocephala</i> open forest over <i>Kunzea glabrescens</i> tall isolated shrubs over <i>Pteridium esculentum</i> sparse fernland and <i>Desmocladius flexuosus</i> open sedgeland.</p> <p>Restricted to one small patch on the northern side of the River.</p>	0.6	-	
<p><b>Scattered natives over weeds (Sn)</b>  <i>Eucalyptus marginata</i>, <i>Corymbia calophylla</i>, <i>Melaleuca preissiana</i> and /or <i>Banksia</i> spp. other weedy grasses and herbs.</p> <p>Characterised as highly modified areas of vegetation where weedy species dominate.</p>	120.6	N/A	
<p><b>Track</b>  Gravel and/ or dirt vehicle tracks</p>	16.9	N/A	

## 4.2 Vegetation condition

The vegetation condition ranged from Excellent to Degraded across the survey area. The majority of the survey area was in Excellent or Very Good condition. In these areas the vegetation structure is intact and there are minimal disturbances. Areas mapped as scattered natives over weeds (Sn) are Degraded in condition as they have been historically cleared/partially cleared to support grazing by livestock. Whilst there is no grazing of livestock today, native species such as kangaroos maintain grazing at high level and contribute to weed spread (as well as keeping weed loads low) (Keighery et al. 1995).

Dieback is present at localised spots throughout the survey area and has contributed to a decline in vegetation condition. A number of patches of *Banksia* Woodland have been impacted by Dieback, which has resulted in death of *Banksia* individuals; these patches have been mapped as Good in condition and occur in the southern part of the survey area. A large patch of *Eucalyptus Banksia* woodland in the north of the survey area was also mapped in Good condition due to sparse occurrences of natives within the mid and lower stratum.

*Banksia Kunzea* woodland vegetation type, is synonymous to *Banksia* Woodland over *Kunzea ericifolia* Closed Tall Shrubland vegetation association mapped by Keighery et al. (1995). Keighery et al. (1995) reported that this association may be linked with regrowth after dieback infection, however, noted that *Kunzea ericifolia* (now recognised as *K. glabrescens* within the survey area) occurs naturally across the SCP in low lying areas. Dieback does appear to have been introduced along the southern boundary from drainage associates with roadworks. (Keighery et al. 1995) noted that in these areas the *Banksia* trees appeared dead or dying, GHD also observed *Banksia* deaths in this area during the field survey.

The north western corner of the survey area was mapped by Keighery et al. (1995) as part of the *Banksia, Allocasuarina fraseriana*, and/or *Melaleuca preissiana* Woodlands to Forests association in Very Good condition. The area has since been subjected to fire and possibly Dieback. As a result the canopy cover is dominated by *B. ilicifolia* amongst stags of what may have historically been other *Banksia* spp. and/or *Allocasuarina*. This area was mapped as Good in condition and separated out from Keighery et al. (1995) original vegetation association due to its modification in species dominance.

The extents of the vegetation condition ratings within the survey area are presented in Table 6 and mapped in Figure 7, Appendix A

**Table 6 Vegetation condition and extent**

Vegetation condition	Extent (ha)
Excellent	354.8
Very Good	441.9
Good	202.7
Degraded	122.7
Tracks	16.9
<b>Total</b>	<b>1,139.0</b>

## 4.3 Conservation significant communities

Based on the results of the desktop searches, previous literature (e.g. Keighery et al. 1995 and Gibson et al. 1994) dominant species, landform features and field observations four conservation significant ecological communities were considered likely to occur within the survey area:

- *Banksia* woodlands of the SCP TEC
- Low lying *Banksia attenuata* woodlands or shrublands (SCP21c) PEC

- *Banksia* dominated woodlands of the SCP IBRA region PEC
- Tuart (*Eucalyptus gomphocephala*) woodlands of the SCP PEC.

All conservation significant communities considered likely to occur within the survey area are described in detail below and mapped in Figure 8, Appendix A.

### ***Banksia* Woodlands of the SCP TEC**

The *Banksia* Woodlands of the SCP was listed in September 2016 as an Endangered TEC under the EPBC Act. The Commonwealth TEC encompasses a number of FCTs, some of which are also listed as State TECs/PECs. The low lying *Banksia attenuata* woodland or shrublands (FCT21c) and the Central *Banksia attenuata* – *B. menziesii* woodlands (FCT23a) are both listed as sub-communities of the *Banksia* Woodlands of the SCP TEC.

The Threatened Species Scientific Community (TSSC) (2016) provides criteria and guidance for determining whether the TEC is present, such as:

- A prominent tree layer of *Banksia*, with scattered eucalypts and other tree species often present among, or emerging above, the canopy
- The understorey is a species rich mix of sclerophyllous shrubs, graminoides and forbs
- High endemism and considerable localised variation in species composition across its range
- Minimum patch size and condition requirements.

Based on the vegetation association and condition mapping by Keighery et al. (1995), updates from DBCA and field survey results the *Eucalyptus Banksia* woodland (EBw), *Allocasuarina Banksia* woodland (ABw) and *Banksia Kunzea* woodland (BKw) vegetation types are considered likely to meet the key diagnostic characteristics for the *Banksia* Woodlands of the SCP TEC. There are five separate patches present within the survey area which are considered representative of the *Banksia* TEC (Table 7). These patches also encompass the Low lying *Banksia attenuata* woodland or shrublands (FCT21c) PEC and *Banksia* dominated woodlands of the SCP IBRA region PEC areas.

**Table 7 Approximate extent of *Banksia* Woodlands of the SCP TEC within the survey area**

Patch ID	Vegetation type	Extent (ha)
1	EBw	48.0
	Patch total	48.0
2	ABw	63.2
	BKw	41.9
	EBw	459.2
	Patch total	564.3
3	EBw	6.5
	Patch total	6.5
4	BKw	37.7
	EBw	127.6
	Patch total	165.3
5	BKw	67.3
	EBw	71.3
	Patch total	138.6
<b>Total</b>		<b>922.7</b>

### **Low lying *Banksia attenuata* woodland or shrublands (FCT21c) PEC**

FCT21c is described as a low lying *Banksia attenuata* woodland or shrublands that occurs sporadically between Gingin and Bunbury. This community is largely restricted to the Bassendean dune system and tends to occupy low lying sites. The *Allocasuarina Banksia* woodland (ABw) and *Banksia Kunzea* woodland (BKw) vegetation types mapped within the survey area are considered representative of FCT21c. These vegetation types included species such as *Banksia attenuata*, *B. menziesii*, *Melaleuca preissiana*, *Eucalyptus marginata*, *Kunzea glabrescens*, *Patersonia occidentalis* and *Desmocladius flexuosus*, which are all typical and common species of FCT21c. There is approximately 210.1 ha of FCT21c present in the survey area.

### ***Banksia* dominated woodlands of the SCP IBRA region PEC**

*Banksia* dominated woodlands of the SCP IBRA region is a Priority 3 PEC listed by DBCA. DBCA (2019) describes the *Banksia* PEC as having a canopy that is most commonly dominated or co-dominated by *Banksia attenuata* and/or *B. menziesii*. Other *Banksia* species that can dominate in the community are *B. prionotes* or *B. ilicifolia*. The PEC differs from the EPBC Act listed *Banksia* woodlands of the SCP TEC in that it has no minimum condition and patch size thresholds.

The Central *Banksia attenuata* – *Eucalyptus marginata* woodlands (FCT21a) and Central *Banksia attenuata* – *B. menziesii* woodlands (FCT23a) were identified within the survey area. These FCTs are not listed as conservation significant communities under the BC Act or by the DBCA. However both FCT21a and FCT23a are considered a component of the *Banksia* dominated woodlands of the SCP IBRA region PEC due to key structural features.

Vegetation type *Eucalyptus Banksia* woodland (EBw) is considered representative of the *Banksia* dominated woodlands of the SCP IBRA region (PEC). There is 712.6 ha of the *Banksia* dominated woodlands of the SCP IBRA region (PEC) within the survey area

### **Tuart (*Eucalyptus gomphocephala*) woodlands of the Swan Coastal Plain (PEC)**

Vegetation type Tuart woodland is considered to align with the Tuart (*Eucalyptus gomphocephala*) woodlands of the SCP PEC, listed as Priority 3 PEC by DBCA. This PEC differs from the TEC in that it has no minimum condition or patch size thresholds. There is 0.6 ha of the PEC present within the survey area.

## **4.4 Conservation significant flora**

Four conservation significant flora have historically been recorded within the survey area:

- *Caladenia huegelii* (listed as EN under the EPBC Act and CR under the BC Act)
- *Drakaea elastica* (listed as EN under the EPBC Act and CR under the BC Act)
- *Johnsonia pubescens* subsp. *cygnorum* (P2) listed by DBCA
- *Dillwynia dillwynioides* (P3) listed by DBCA

During the field survey a new location of *Johnsonia pubescens* subsp. *cygnorum* (P2) was recorded. The location of this conservation significant species is illustrated on Figure 8, Appendix A.

## **4.5 Significant weeds**

During the field survey four Declared Pests as listed under the *Biosecurity and Management Act 2007* were recorded in multiple locations throughout the survey area. One taxon is also listed as Weeds of National Significance (WoNS):

- \**Gomphocarpus fruticosus* (Narrowleaf Cottonbush) – Declared Pest
- \**Echium plantagineum* (Paterson's Curse) – Declared Pest
- \**Zantedeschia aethiopica* (Arum lily) – Declared Pest
- \**Asparagus asparagoides* (Bridal Creeper) – Declared Pest and WoNS

Locations of the Declared Pests and WoNS recorded during the field survey are shown in Figure 7, Appendix A

#### **4.6 Broad fauna habitats**

Four broad habitats were identified within the survey area based on the mapped vegetation types. The fauna habitats are described in Table 8 and mapped in Figure 9, Appendix A.

The survey area is an intact area of native vegetation dominated by mixed Eucalyptus and Banksia woodlands interspersed with partial clearings and lower elevation areas with associated damp land vegetation associations. The survey area is mostly surrounded by cleared land with low density semi-rural residential properties and has limited connectivity to other areas of bushland. The Serpentine River intersects the central part of the survey area and there is some connectivity along this river via riparian woodland, and remnant patches of scattered trees in the surrounding setting provide some canopy connectivity. Access to the survey area is via a private road and locked gate which has minimised vehicle and bike activity as well as illegal dumping.

**Table 8 Broad fauna habitats within the survey area**

Habitat type and description	Value	Extent (ha)	Photographs
<p><b>Mixed Eucalyptus Banksia Woodland</b></p> <p>Corresponding vegetation associations: EBW, ABw, BiW, BKw</p> <p>The habitat comprises Bassendean sand plain supporting emergent Marri and Jarrah trees over a mature canopy of <i>Banksia</i> with Sheoaks and Paperbarks in lower lying areas. The midstorey varies from open, moderately dense, or scattered patches of Bassendean derived mixed shrubs such as <i>Jacksonia</i>, <i>Acacia</i> and <i>Kunzea</i>. Lower strata vegetation consists of a diverse mix of low shrubs and forbs including <i>Xanthorrhoea</i> and <i>Loxocarya</i>. This habitat type contains good structural diversity and is likely to provide a variety of micro-habitat types including logs, soft sand, leaf litter and woody debris for a range of small to medium sized terrestrial vertebrate mammals and reptiles. The mid strata shrubs and trees support a range of small insectivorous and nectar feeding birds. Emergent mature Jarrah and Marri trees are present and provide potential breeding habitat for black cockatoos.</p> <p><u>Conservation Significant Fauna</u></p> <p>This habitat provides resources for conservation significant fauna including:</p> <ul style="list-style-type: none"> <li>• Carnaby's Cockatoo (<i>Calyptorhynchus latirostris</i>) (foraging, and potential breeding and roosting)</li> <li>• Forest Red-tailed Black Cockatoo (<i>Calyptorhynchus banksii naso</i>) (foraging, and potential breeding and roosting)</li> <li>• Baudin's Cockatoo (<i>Calyptorhynchus baudinii</i>) (foraging and potential roosting)</li> <li>• Quenda (<i>Isodoon fusciventer</i>) (foraging)</li> <li>• South-western Brush-tailed Phascogale (<i>Phascogale tapoatafa wambenger</i>) (foraging, shelter/refuge)</li> <li>• Coastal Plains Skink (<i>Ctenotus ora</i>) (foraging/shelter).</li> <li>• Chuditch (<i>Dasyurus geoffroi</i>) (foraging)</li> </ul>	High	940.3	

Habitat type and description	Value	Extent (ha)	Photographs
<p><b>Flooded Gum Melaleuca woodlands</b></p> <p>Corresponding vegetation associations: Mw, Cw</p> <p>This habitat comprised an overstorey of Paperbarks with occasional emergent Marri and Flooded gum over sparse to dense shrublands and mixed herbs and sedges, and introduced species such as Arum Lily. This habitat type occurs in lower elevation poor retainage damplands and ephemeral swamp areas, There is moderate structural diversity and is likely to be seasonally inundated. The midstorey and understorey may be dense enough to support small ground dwelling mammals and reptiles, however, the waterlogged soils may prevent soil living fauna from utilizing the area. The Quenda would not utilise areas that are seasonally inundated, but would utilise habitat on the margins that are dense and accessible.</p> <p><u>Conservation Significant Fauna</u></p> <p>This habitat provides resources for conservation significant fauna including:</p> <ul style="list-style-type: none"> <li>• Carnaby's Cockatoo (potential breeding and roosting)</li> <li>• Forest Red-tailed Black Cockatoo (potential breeding and roosting)</li> <li>• Baudin's Cockatoo (potential roosting)</li> <li>• Southern Brown Bandicoot (foraging)</li> <li>• Quenda (resident, foraging)</li> <li>• Chuditch (<i>Dasyurus geoffroi</i>) (foraging)</li> </ul>	Moderate	24.5	

Habitat type and description	Value	Extent (ha)	Photographs
<p><b>Riparian</b></p> <p>Corresponding vegetation associations: Ef, Emw, Tw</p> <p>Riparian habitat includes banks of the Serpentine River, the waterway and associated tributaries, and sumpland areas. This habitat type comprises dense and very tall stands of Flooded gum forest with occasional Tuart and Paperbarks over Bracken and sedges. This habitat type contains good structural diversity and is likely to provide a variety of micro-habitat types including large logs and other fallen timber, dense patches of ferns and thick litter. This habitat is likely to provide excellent cover and foraging opportunities for birds and reptiles, and there is extensive signs of Quenda foraging activity. The understorey vegetation also provides refuge and foraging opportunities for mammals such as the Quenda and habitat on the river margins for Rakali.</p> <p>The Serpentine River provides habitat for aquatic species such as fish, crustaceans and amphibians.</p> <p><u>Conservation Significant Fauna</u></p> <p>This habitat provides resources for conservation significant fauna including:</p> <ul style="list-style-type: none"> <li>• Carnaby’s Cockatoo (potential breeding and roosting)</li> <li>• Forest Red-tailed Black Cockatoo (potential breeding and roosting)</li> <li>• Baudin’s Cockatoo (potential roosting)</li> <li>• Rakali (<i>Hydromys chrysogaster</i>) (feeding and shelter)</li> <li>• Quenda (resident, foraging)</li> <li>• Carter’s Freshwater Mussel (<i>Westralunio carteri</i>) (resident)</li> <li>• Pouched lamprey (<i>Geotria australia</i>)</li> <li>• Chuditch (<i>Dasyurus geoffroi</i>) (foraging, movement corridor regionally)</li> </ul>	High	36.6	

Habitat type and description	Value	Extent (ha)	Photographs
<p><b>Pasture with scattered trees</b></p> <p>Corresponding vegetation associations: Sn</p> <p>This habitat type is largely cleared except for remnant trees and few shrubs. It contains poor structural diversity with a scattered overstorey, limited mid-storey and understorey of pasture weeds. The scattered trees include mainly Jarrah, Marri and occasional Flooded gum and or <i>Banksia</i> species. Tree density varies from very sparse to small clusters. A lack of low strata native vegetation coverage (native understorey and ground layer) is replaced by pasture and weed grasses and exotic herbaceous species which makes the area largely unsuitable for most small mammals, and reptiles. The mature trees provide opportunistic foraging, and potential breeding and may provide potential roosting habitat (dependant on size of each tree) for black cockatoo species. This habitat type includes patches of highly degraded clay pan supporting weed species.</p> <p><u>Conservation Significant Fauna</u></p> <p>The habitat within the survey area provides resources for conservation significant fauna including:</p> <ul style="list-style-type: none"> <li>• Carnaby's Cockatoo (foraging, potential breeding and roosting)</li> <li>• Forest Red-tailed Black Cockatoo (foraging, potential breeding and roosting)</li> <li>• Baudin's Cockatoo (foraging and potential roosting)</li> <li>• South-western Brush-tailed Phascogale (foraging, shelter/refuge)</li> </ul>	Moderate	120.6	
<b>Tracks</b>		16.9	

## 4.7 Black cockatoo habitat assessment

### 4.7.1 Foraging habitat

During the one day field visit, Carnaby's Cockatoos were seen and heard calling over the survey area. Forest Red-tailed Black Cockatoos were also observed feeding at two locations during the subsequent two day field assessment. Foraging evidence (chewed Marri, Jarrah, Banksia and Allocasuarina nuts) was recorded extensively throughout the Mixed Eucalyptus Banksia Sheoak, and Scattered native tree habitat types with both Carnaby's Cockatoo and Forest Red-tailed Black Cockatoo distinctive mandible marks evident.

The type and quality of plant species provides extensive and high quality food resources for both Carnaby's Cockatoo and Forest Red-tailed Black Cockatoo. The survey area is also considered to contain foraging and potential roosting habitat for Baudin's Cockatoo, however no evidence of feeding or roosting was observed. A summary of potential black cockatoo habitat available within the survey area is provided in Table 9. Foraging, potential breeding and roosting habitat for Black Cockatoos is mapped in Figure 9, Appendix A. Foraging evidence recorded during the survey is mapped in Figure 10, Appendix A

### 4.7.2 Breeding habitat

From tree density plots the potential breeding trees (DBH greater than 50 cm) were recorded within all four of the major habitat types. Potential breeding trees were recorded at greatest density within the Riparian habitat and lowest density recorded in the Scattered native tree habitat (Table 10). The presence of extensive and high quality foraging resource throughout the survey area enhances the value potential breeding trees.

### 4.7.3 Roosting habitat

The survey area does not support any known roosts, however the 2018 Great Cocky Count (Peck et al. 2018) reports multiple confirmed roost sites for Carnaby's Cockatoo within a 12 km radius of the Lowlands survey area.

**Table 9 Black cockatoo habitat within the survey area**

Habitat type	Extent (ha)	Foraging	Potential breeding	Potential roosting
Mixed Eucalyptus Banksia Sheoak woodland	940.3	high	yes	no
Scattered native trees	120.6	low/ mod	yes	no
Flooded Gum Melaleuca woodland	24.5	low/mod	yes	no
Riparian	36.6	low/mod	yes	yes

**Table 10 Potential breeding tree density**

Habitat type	No. of plots sampled	Density range (trees/ha)	Mean (trees/ha)	Estimated trees in habitat type
Mixed Eucalyptus Banksia Sheoak woodland	23	0 - 16	6.3	5,923
Scattered native trees	5	0 - 8	2.4	289
Flooded Gum Melaleuca woodland	5	0 - 8	4.0	98
Riparian	5	32 - 76	48.8	1,786

## 4.8 Conservation significant fauna

The DBCA are currently using camera traps within the survey area to detect fauna species present. During the site visit, GHD ecologists were shown photographs of some of the conservation significant fauna species recorded within the site, these included:

- Chuditch (*Dasyurus geoffroi*) (a single male individual)
- Rakali (*Hydromys chrysogaster*)
- Pouched lamprey (*Geotria australia*)
- Carters Freshwater Mussel (*Westralunio carteri*)
- Quenda (*Isodoodon fusciventer*)
- Brush-tailed Phascogale (*Phascogale tapoatafa wambenger*).

Property owner and resident Margaret Richardson provided anecdotal evidence on the conservation significant fauna within the reserve:

- Quenda are frequently observed around the immediate homestead where they shelter from foxes and are also seen throughout much of the reserve
- Tammar Wallabies (*Notamacropus eugenii derbianus*) have been recorded historically on the reserve but not seen for many years
- Brush-tailed Phascogales have been recorded in the woodland areas
- Carter's Freshwater Mussels were collected upstream of the reserve in a study and are thought to spawn in the Serpentine River within the reserve; Pouched lamprey were also captured in this study
- Carnaby's Cockatoo and Forest Red-tailed Black Cockatoo are both frequent visitors and residents at the reserve.

Sheenan et al. (2017) reported that the riverine system within the site provides spawning grounds for Carters Freshwater Mussels and Pouched lamprey. Carter's Freshwater Mussels were recorded within the Serpentine River in the survey area during the survey. The river also provides important habitat for threatened mammals including Rakali and Quenda. Signs of presence, and direct observation of all conservation significant fauna recorded during the survey are presented in Figure 10, Appendix A.

### **Likelihood of occurrence assessment**

An assessment of the likelihood of occurrence for conservation significant fauna in the survey area was conducted. This assessment was based on species biology, habitat requirements, the quality and connectivity of available habitat, and local and regional occurrence of species records. The assessment identified eight species that are known to occur within the survey area. A summary of the assessment is provided in Table 11.

**Table 11 Summary of conservation significant fauna likelihood of occurrence assessment**

Species	Common Name	BC Act / DBCA	EPBC	Likelihood of occurrence
<i>Calyptorhynchus banksii naso</i>	Forest Red-tailed Black Cockatoo	VU	VU	<b>Known</b> Confirmed present. Extensive signs of foraging on Marri, Jarrah and <i>Allocasuarina</i> nuts was recorded, as well as small flocks of active cockatoos observed. The survey area has foraging, potential breeding and roosting habitat.
<i>Calyptorhynchus latirostris</i>	Carnaby's Cockatoo	EN	EN	<b>Known</b> Confirmed present. Extensive signs of foraging of <i>Banksia attenuata</i> , <i>B. grandis</i> , <i>B. menziesii</i> and <i>B. ilicifolia</i> . The survey area has foraging, potential breeding and roosting habitat.
<i>Calyptorhynchus baudinii</i>	Baudin's Cockatoo	VU	VU	<b>Likely</b> The survey area has foraging and potential roosting habitat
<i>Oxyura australis</i>	Blue-billed Duck	P4		<b>Unlikely</b> This species prefers large deep lakes and wetlands which the site does not provide. The Serpentine River represents limited and sub-optimal habitat.
<i>Dasyurus geoffroii</i>	Chuditch, Western Quoll	VU	VU	<b>Known</b> Confirmed present
<i>Hydromys chrysogaster</i>	Water-rat, Rakali	P4		<b>Known</b> Confirmed present. This species is likely to be a resident along the Serpentine Rv.
<i>Isoodon fusciventer</i>	Quenda, South-western Brown Bandicoot	P4		<b>Known</b> Confirmed present. Foraging signs (diggings) recorded during the field survey.
<i>Notamacropus eugenii derbianus</i>	Tammar Wallaby	P4		<b>Unlikely</b> Historically recorded on site. The site lacks suitable and/or connected habitat for the Tammar Wallaby.
<i>Phascogale tapoatafa wambenger</i>	South-western Brush-tailed Phascogale	CD		<b>Known</b> Confirmed present.
<i>Westralunio carteri</i>	Carter's Freshwater Mussel	VU	VU	<b>Known</b> Confirmed present. This species recorded within Serpentine River during the field survey.
<i>Geotria australia</i>	Pouched lamprey	P3		<b>Known</b> Confirmed present

## 5. Opportunities for on ground management work

Based on discussions with stakeholders and the two-day field survey the following on ground maintenance will need to be considered:

- Maintenance of existing fences and gates, fencing upgrade/replacement in the southern part of the survey area
- Weed management and targeted control for significant weeds including but not limited to Arum lily (*Zantedeschia aethiopica*), Bridal creeper (*Asparagus asparagoides*), Cotton bush (*Gomphocarpus fruticosus*) and \**Echium plantagineum* (Paterson's Curse)
- Feral animal control including rabbits, foxes, pigs, goats, dogs and possibly cats
- Potential control of native fauna such as kangaroos to minimise weed invasion into area of Banksia Woodlands
- Revegetation of areas along the Serpentine River and in patches of degraded Banksia Woodland. Revegetation will improve fauna habitats by increasing foraging, breeding and shelter values, particularly for the eight conservation significant fauna species
- Continued dieback management through implementation of the existing Hygiene Management Plan maintenance of dieback vehicle wash-down bays and signage throughout the reserve.
- Consider installation of artificial nest tubes for Carnaby's and Forest Red-tailed Black Cockatoos, and nest boxes for Brush-tailed Phascogale
- Consider including the survey area in the Great Cocky Count autumn roost survey, which is coordinated by Birdlife Australia. This may establish whether the survey area is being used as a Black Cockatoo roost survey area.

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# Appendices

# **Appendix A – Figures**

**Figure 1 Location**

**Figure 2 Hydrological constraints**

**Figure 3 Land use constraints**

**Figure 4 Vegetation complexes**

**Figure 5 Biological constraints**

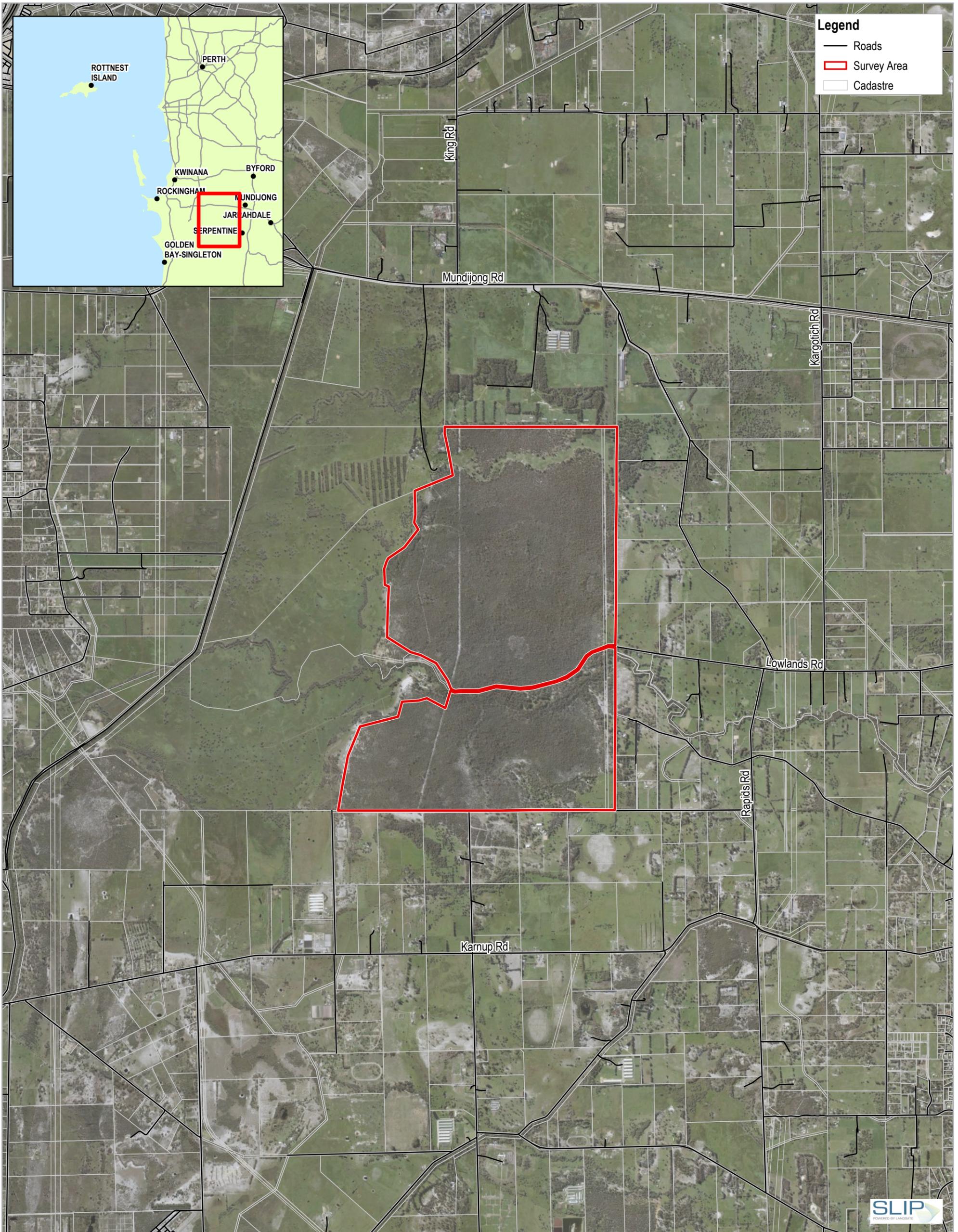
**Figure 6 Vegetation types**

**Figure 7 Vegetation condition**

**Figure 8 Conservation significant communities**

**Figure 9 Fauna habitats and Black Cockatoo values**

**Figure 10 Significant fauna observations**



**Legend**

- Roads
- ▭ Survey Area
- ▭ Cadastre

Paper Size ISO A3

Kilometres

Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 Perth Coastal Grid 1994

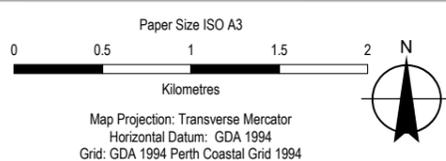
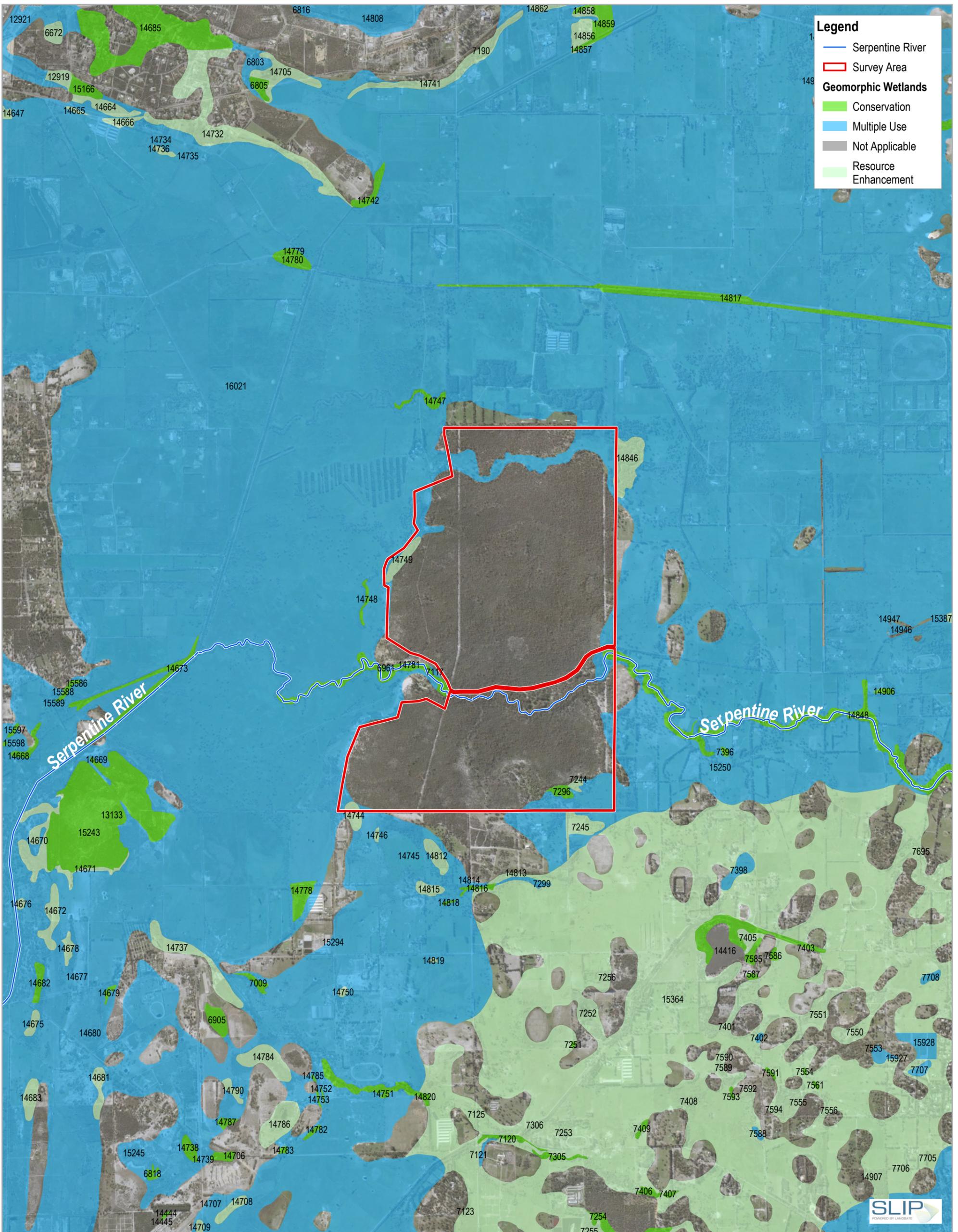


**PTA**  
PTA Potential Offset Site Environmental  
Assessment Lowlands

**Lowlands Site Location**

Project No. 61-38451-03  
Revision No. 0  
Date 25/11/2019

**FIGURE 1**

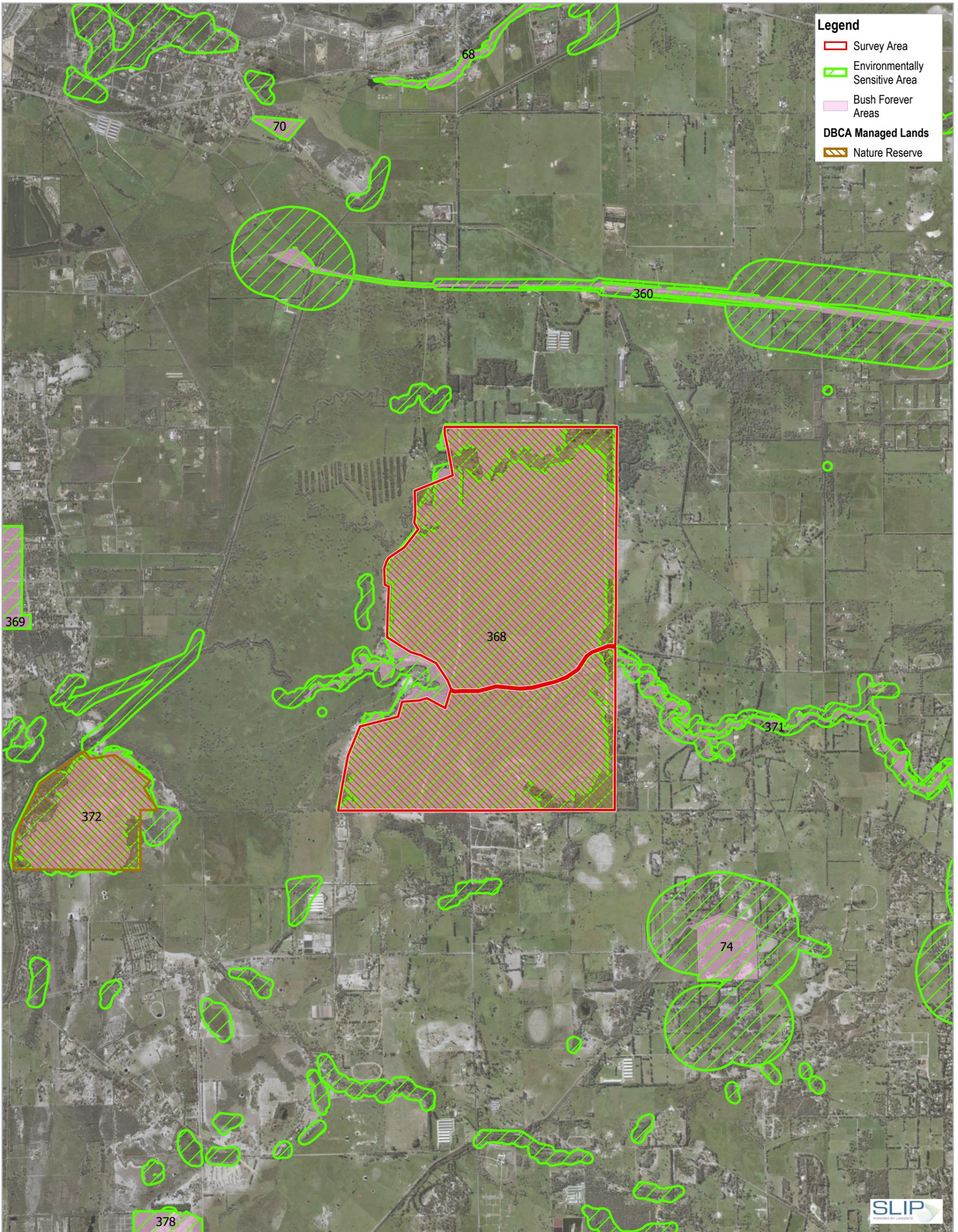


PTA  
PTA Potential Offset Site Environmental  
Assessment Lowlands

Hydrological constraints

Project No. 61-38451-03  
Revision No. 0  
Date 25/11/2019

FIGURE 2



**Legend**

- Survey Area
- Environmentally Sensitive Area
- Bush Forever Areas

**DBCA Managed Lands**

- Nature Reserve

Paper Size ISO A3

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Kilometres

Map Projection: Transverse Mercator  
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Grid: GDA 1994 Perth Coastal Grid 1994

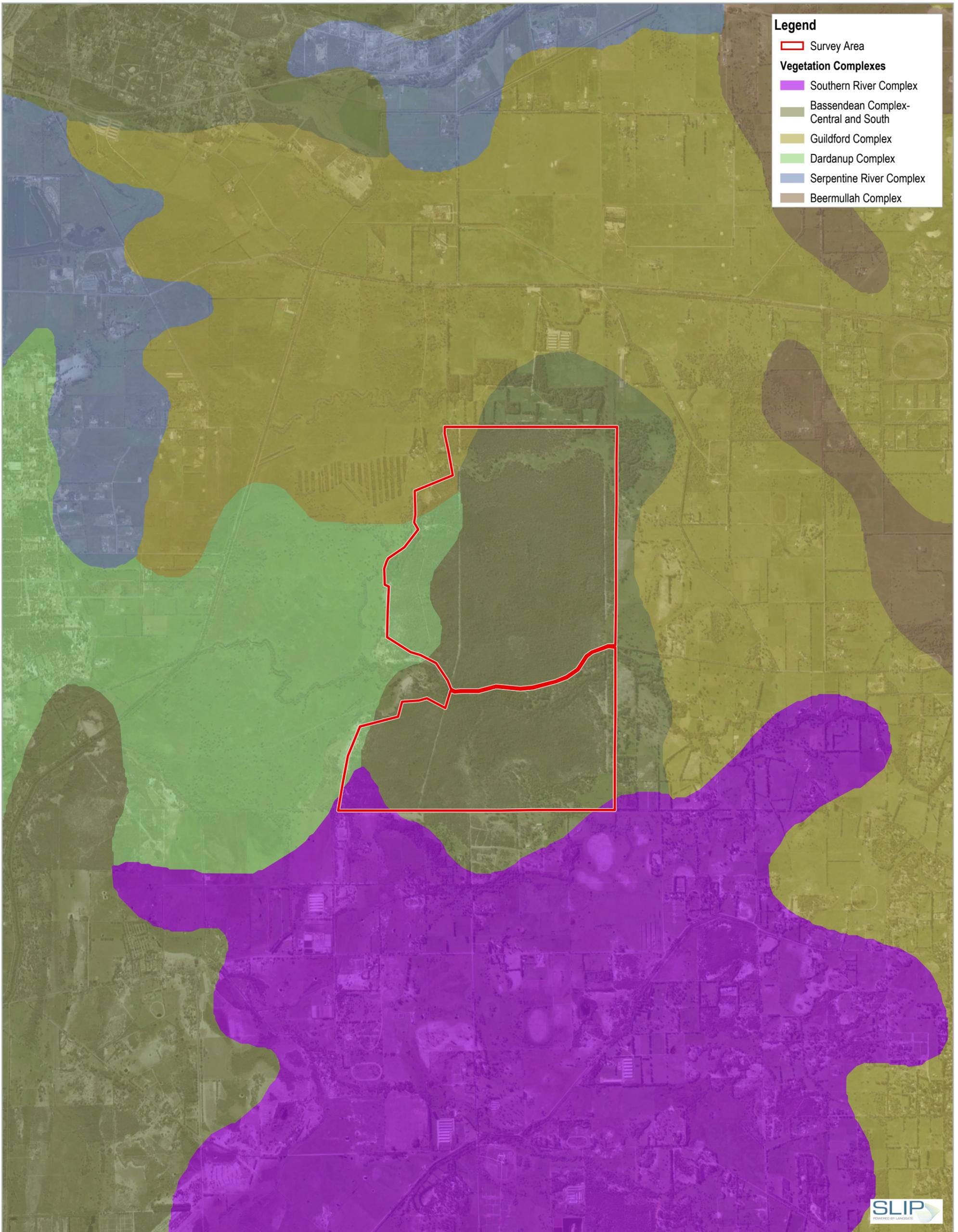


**PTA**  
PTA Potential Offset Site Environmental  
Assessment Lowlands

**Land use constraints**

Project No. 61-38451-03  
Revision No. 0  
Date 25/11/2019

**FIGURE 3**



**Legend**

- Survey Area
- Vegetation Complexes**
- Southern River Complex
- Bassendean Complex-Central and South
- Guildford Complex
- Dardanup Complex
- Serpentine River Complex
- Beermullah Complex



Paper Size ISO A3

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Kilometres

Map Projection: Transverse Mercator  
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Grid: GDA 1994 Perth Coastal Grid 1994

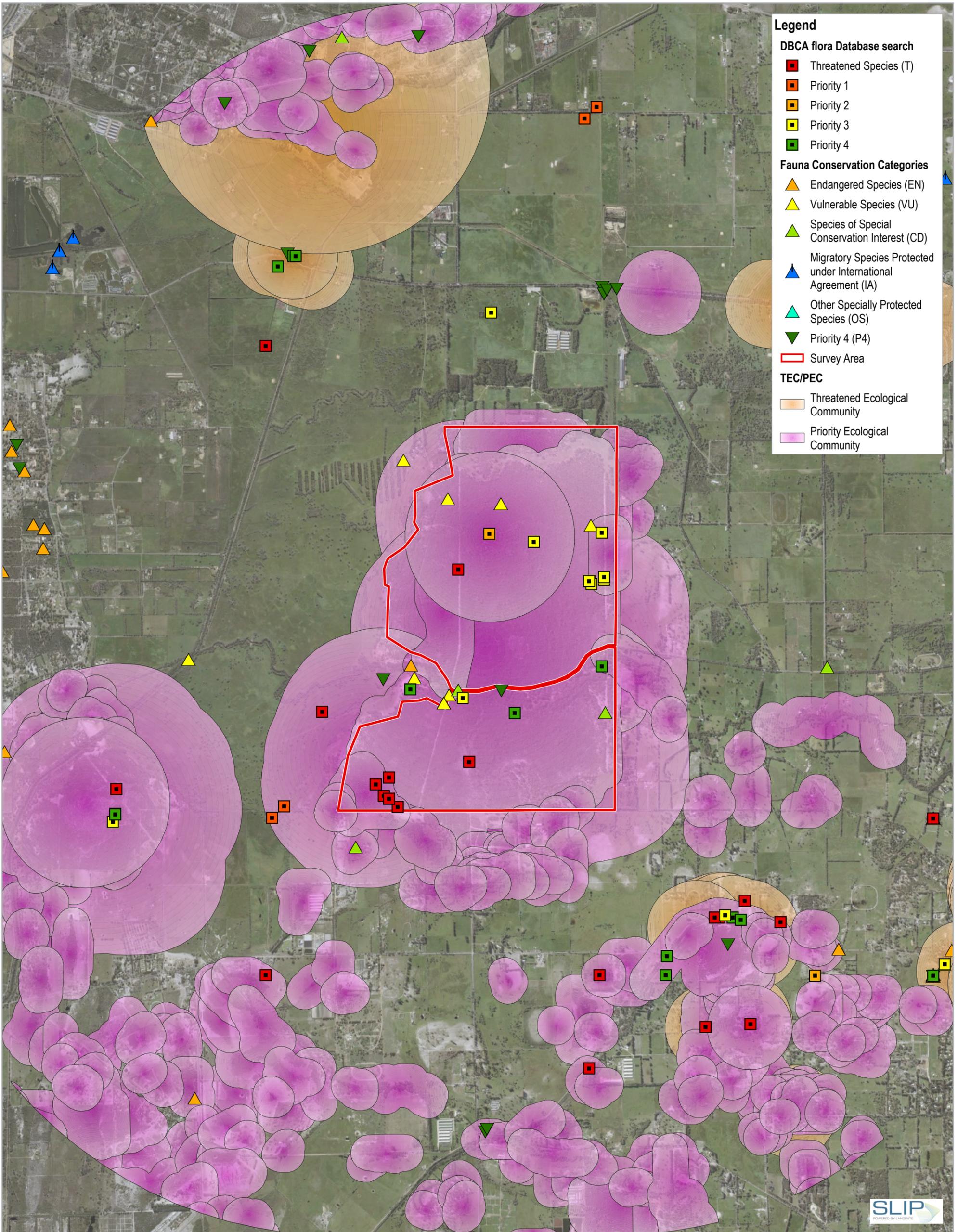


**PTA**  
**PTA Potential Offset Site Environmental**  
**Assessment Lowlands**

**Vegetation Complexes**

Project No. **61-38451-03**  
Revision No. **0**  
Date **25/11/2019**

**FIGURE 4**



Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 Perth Coastal Grid 1994



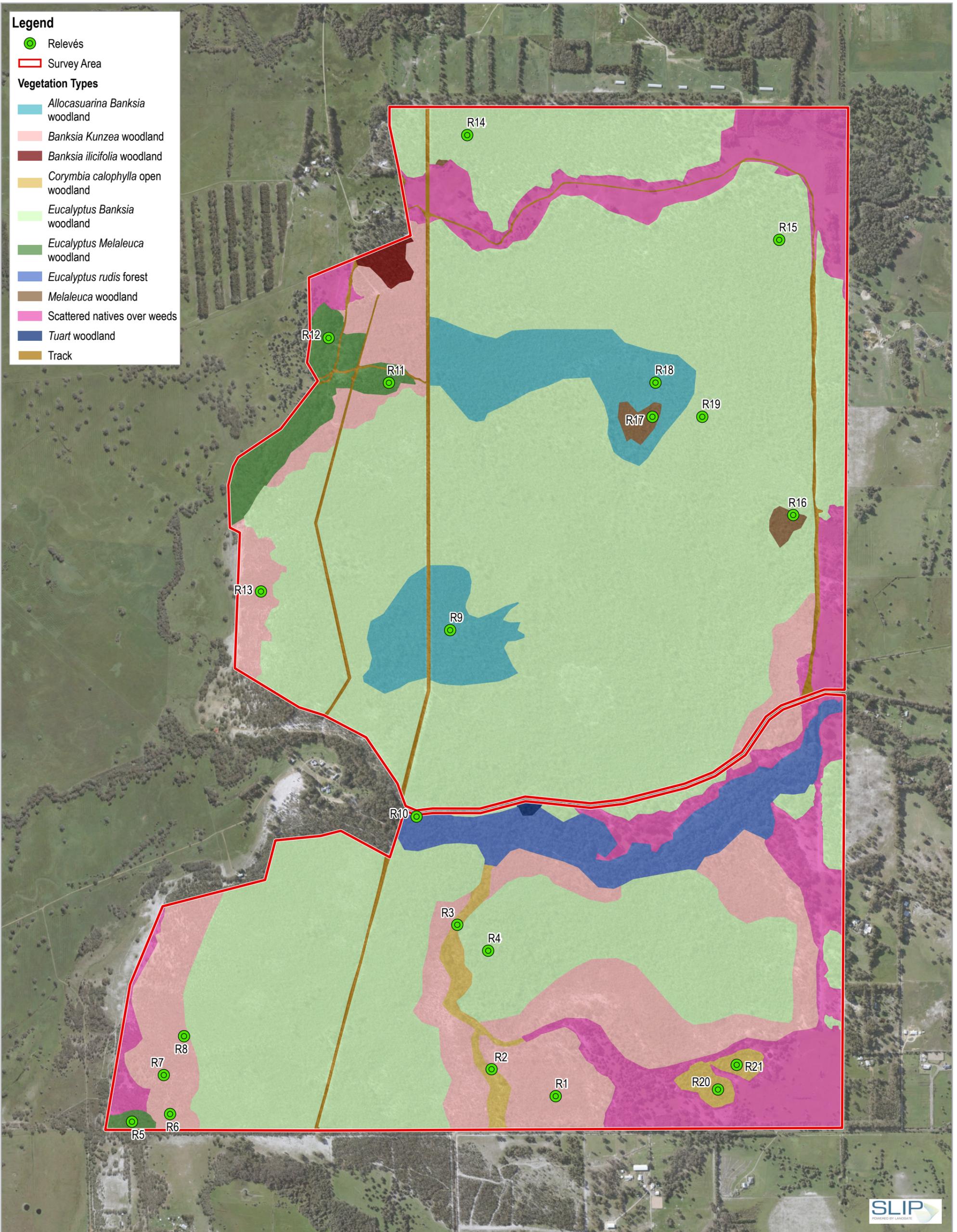
PTA  
PTA Potential Offset Site Environmental  
Assessment Lowlands

**Biological Constraints**

Project No. 61-38451-03  
Revision No. 0  
Date 25/11/2019

**FIGURE 5**

- Legend**
-  Relevés
  -  Survey Area
- Vegetation Types**
-  *Allocasuarina Banksia* woodland
  -  *Banksia Kunzea* woodland
  -  *Banksia ilicifolia* woodland
  -  *Corymbia calophylla* open woodland
  -  *Eucalyptus Banksia* woodland
  -  *Eucalyptus Melaleuca* woodland
  -  *Eucalyptus rudis* forest
  -  *Melaleuca* woodland
  -  Scattered natives over weeds
  -  *Tuart* woodland
  -  Track



Paper Size ISO A3  
 0 100 200 300 400  
 Metres

Map Projection: Transverse Mercator  
 Horizontal Datum: GDA 1994  
 Grid: GDA 1994 Perth Coastal Grid 1994



PTA  
 PTA Potential Offset Site Environmental  
 Assessment Lowlands

**Vegetation types and  
 sample sites**

Project No. 61-38451-03  
 Revision No. 0  
 Date 7/02/2020

**FIGURE 6**

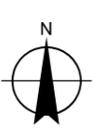
**Legend**

- Survey Area
- Significant Weeds**
- ▲ \**Zantedeschia aethiopica* DP
- ▲ \**Asparagus asparagoides* WoNS and DP
- ▲ \**Gomphocarpus fruticosus* DP
- ▲ \**Echium plantagineum* DP
- Vegetation Condition**
- Excellent
- Very Good
- Good
- Degraded
- Tracks



Paper Size ISO A3  
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 Metres

Map Projection: Transverse Mercator  
 Horizontal Datum: GDA 1994  
 Grid: GDA 1994 Perth Coastal Grid 1994



PTA  
 PTA Potential Offset Site Environmental  
 Assessment Lowlands

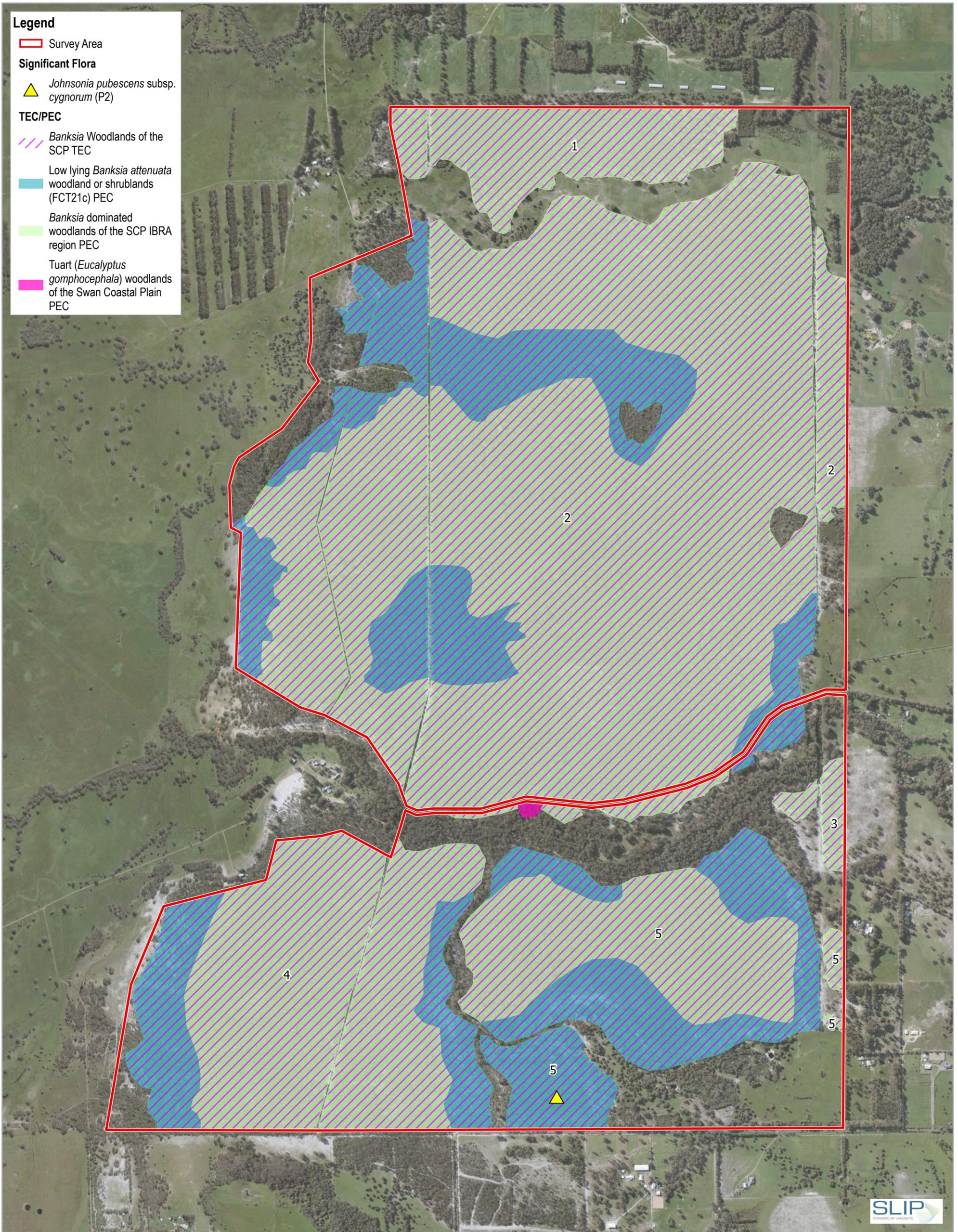
**Vegetation condition and  
 significant weeds**

Project No. 61-38451-03  
 Revision No. 0  
 Date 7/02/2020

**FIGURE 7**

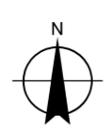
**Legend**

- Survey Area
- Significant Flora**
- ▲ *Johnsonia pubescens* subsp. *cygnorum* (P2)
- TEC/PEC**
- Banksia* Woodlands of the SCP TEC
- Low lying *Banksia attenuata* woodland or shrublands (FCT21c) PEC
- Banksia* dominated woodlands of the SCP IBRA region PEC
- Tuart (*Eucalyptus gomphocephala*) woodlands of the Swan Coastal Plain PEC



Paper Size ISO A3  
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 Metres

Map Projection: Transverse Mercator  
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 Grid: GDA 1994 Perth Coastal Grid 1994

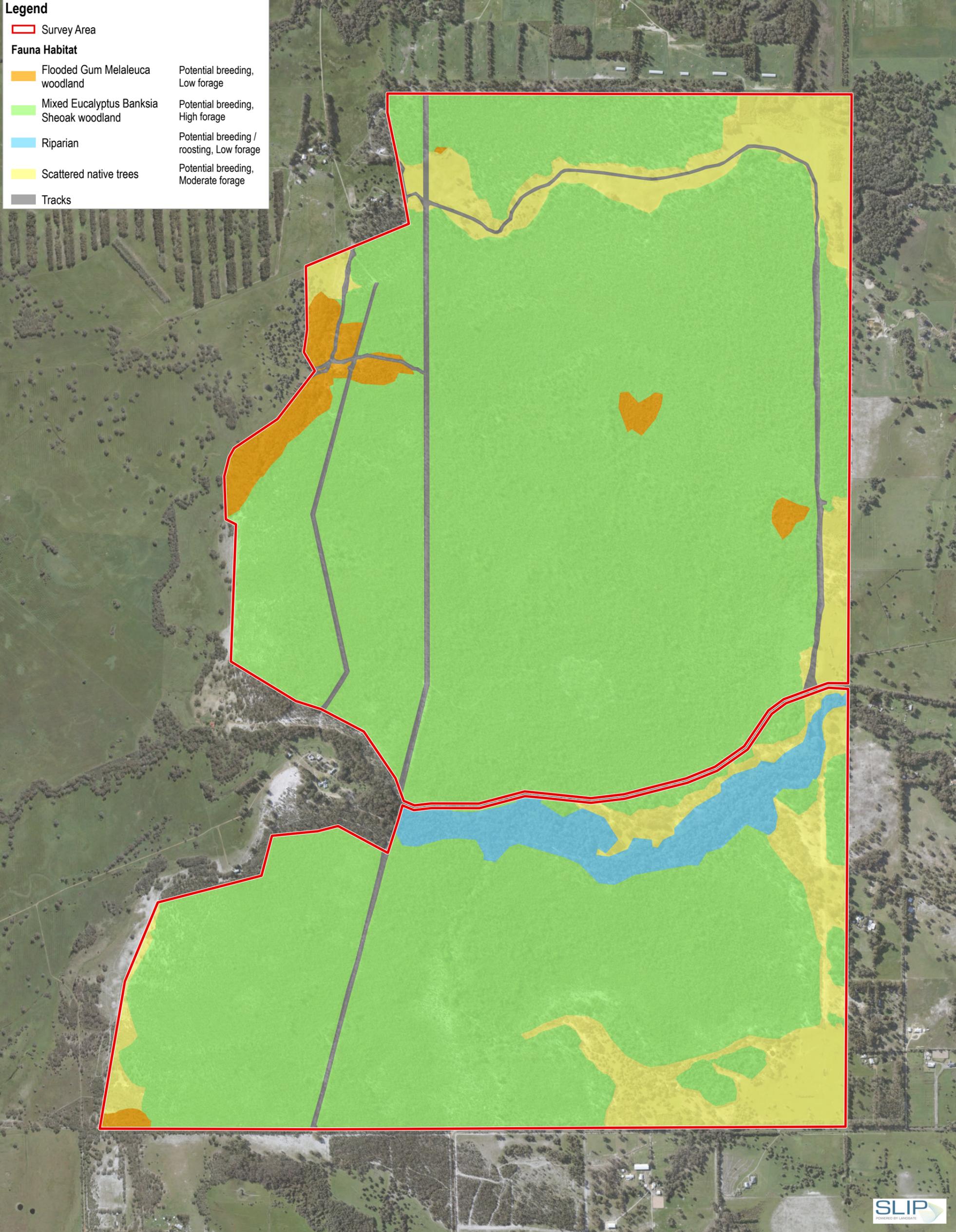


PTA  
 PTA Potential Offset Site Environmental  
 Assessment Lowlands

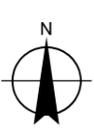
**Conservation significant communities  
 and significant flora**

Project No. 61-38451-03  
 Revision No. 0  
 Date 7/02/2020

**FIGURE 8**



Paper Size ISO A3  
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 Metres  
 Map Projection: Transverse Mercator  
 Horizontal Datum: GDA 1994  
 Grid: GDA 1994 Perth Coastal Grid 1994



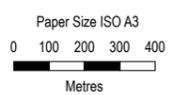
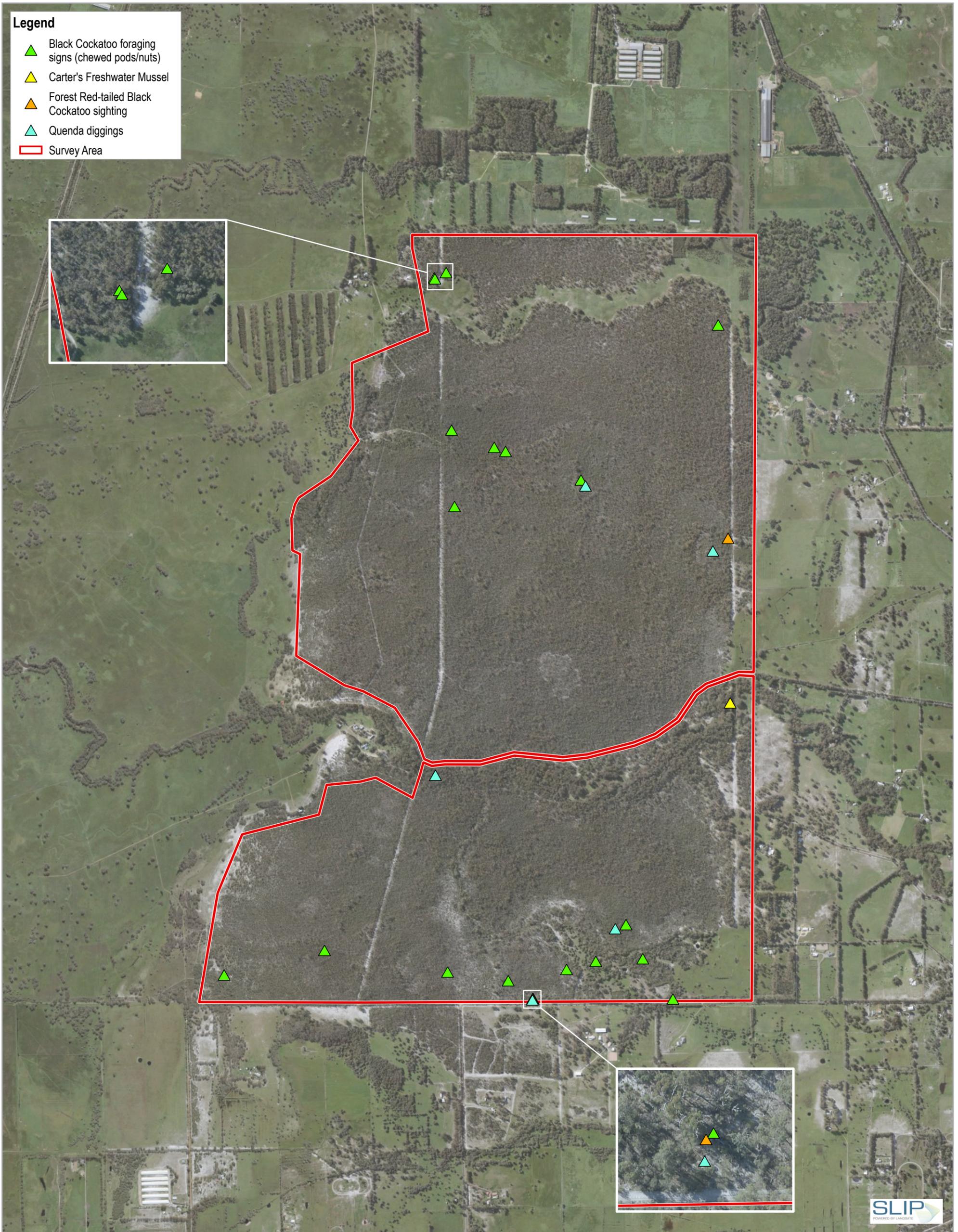
PTA  
 PTA Potential Offset Site Environmental  
 Assessment Lowlands

Project No. 61-38451-03  
 Revision No. 0  
 Date 7/02/2020

**Fauna habitats and  
 Black Cockatoo values**

**FIGURE 9**

- Legend**
- ▲ Black Cockatoo foraging signs (chewed pods/nuts)
  - ▲ Carter's Freshwater Mussel
  - ▲ Forest Red-tailed Black Cockatoo sighting
  - ▲ Quenda diggings
  - Survey Area



Map Projection: Transverse Mercator  
 Horizontal Datum: GDA 1994  
 Grid: GDA 1994 Perth Coastal Grid 1994



PTA  
 PTA Potential Offset Site Environmental  
 Assessment Lowlands

Project No. 61-38451-03  
 Revision No. 0  
 Date 7/02/2020

**Significant fauna observations**

**FIGURE 10**

## **Appendix B** – Desktop searches

NatureMap Flora (5 km buffer)

NatureMap fauna (5 km buffer)

# Mardella CS flora report

Created By Guest user on 17/07/2019

**Kingdom** Plantae  
**Conservation Status** Conservation Taxon (T, X, IA, S, P1-P5)  
**Current Names Only** Yes  
**Core Datasets Only** Yes  
**Method** 'By Circle'  
**Centre** 115° 54' 50" E, 32° 19' 50" S  
**Buffer** 5km  
**Group By** Family

Family	Species	Records
Apiaceae	1	1
Apocynaceae	1	2
Asteraceae	1	1
Cyperaceae	2	2
Fabaceae	3	10
Hemerocallidaceae	1	4
Myrtaceae	2	5
Orchidaceae	2	9
Proteaceae	2	7
<b>TOTAL</b>	<b>15</b>	<b>41</b>

Name ID	Species Name	Naturalised	Conservation Code	<sup>1</sup> Endemic To Query Area
<b>Apiaceae</b>				
1.	41801 <i>Eryngium pinnatifidum</i> subsp. <i>Palustre</i> (G.J. Keighery 13459)		P3	
<b>Apocynaceae</b>				
2.	6573 <i>Parsonia diaphanophleba</i>		P4	
<b>Asteraceae</b>				
3.	7829 <i>Angianthus drummondii</i>		P3	
<b>Cyperaceae</b>				
4.	759 <i>Carex tereticaulis</i>		P3	
5.	1033 <i>Tetragia australiensis</i>		T	
<b>Fabaceae</b>				
6.	14932 <i>Acacia lasiocarpa</i> var. <i>bracteolata</i> long peduncle variant (G.J. Keighery 5026)		P1	
7.	3863 <i>Dillwynia dillwynioides</i>		P3	
8.	20462 <i>Jacksonia gracillima</i>		P3	
<b>Hemerocallidaceae</b>				
9.	19272 <i>Johnsonia pubescens</i> subsp. <i>cygnorum</i>		P2	
<b>Myrtaceae</b>				
10.	13512 <i>Eucalyptus rudis</i> subsp. <i>cratyantha</i>		P4	
11.	14714 <i>Verticordia lindleyi</i> subsp. <i>lindleyi</i>		P4	
<b>Orchidaceae</b>				
12.	1596 <i>Caladenia huegelii</i> (Grand Spider Orchid)		T	
13.	1639 <i>Drakaea elastica</i> (Glossy-leaved Hammer Orchid)		T	
<b>Proteaceae</b>				
14.	30751 <i>Synaphea</i> sp. <i>Pinjarra Plain</i> (A.S. George 17182)		T	
15.	28354 <i>Synaphea</i> sp. <i>Serpentine</i> (G.R. Brand 103)		T	

#### Conservation Codes

T - Rare or likely to become extinct  
X - Presumed extinct  
IA - Protected under international agreement  
S - Other specially protected fauna  
1 - Priority 1  
2 - Priority 2  
3 - Priority 3  
4 - Priority 4  
5 - Priority 5

<sup>1</sup> For NatureMap's purposes, species flagged as endemic are those whose records are wholly contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

# Mardella CS fauna report

Created By Guest user on 17/07/2019

**Kingdom** Animalia  
**Conservation Status** Conservation Taxon (T, X, IA, S, P1-P5)  
**Current Names Only** Yes  
**Core Datasets Only** Yes  
**Method** 'By Circle'  
**Centre** 115° 54' 50" E, 32° 19' 50" S  
**Buffer** 5km  
**Group By** Species Group

Species Group	Species	Records
Bird	4	9
Invertebrate	1	2
Mammal	6	20
<b>TOTAL</b>	<b>11</b>	<b>31</b>

Name ID	Species Name	Naturalised	Conservation Code	<sup>1</sup> Endemic To Query Area
<b>Bird</b>				
1.	24731 <i>Calyptorhynchus banksii</i> subsp. <i>naso</i> (Forest Red-tailed Black Cockatoo)		T	
2.	24734 <i>Calyptorhynchus latirostris</i> (Carnaby's Cockatoo, White-tailed Short-billed Black Cockatoo)		T	
3.	48400 <i>Calyptorhynchus</i> sp. (white-tailed black cockatoo)		T	
4.	24328 <i>Oxyura australis</i> (Blue-billed Duck)		P4	
<b>Invertebrate</b>				
5.	34113 <i>Westralunio carteri</i> (Carter's Freshwater Mussel)		T	
<b>Mammal</b>				
6.	24092 <i>Dasyurus geoffroi</i> (Chuditch, Western Quoll)		T	
7.	24215 <i>Hydromys chrysogaster</i> (Water-rat, Rakali)		P4	
8.	48588 <i>Isodon fusciventer</i> (Quenda, southwestern brown bandicoot)		P4	
9.	48024 <i>Notamacropus eugenii</i> subsp. <i>derbianus</i> (Tammar Wallaby, Tammar)		P4	
10.	25508 <i>Phascogale tapoatafa</i> (Brush-tailed Phascogale)		S	
11.	48070 <i>Phascogale tapoatafa</i> subsp. <i>wambenger</i> (South-western Brush-tailed Phascogale, Wambenger)		S	

**Conservation Codes**

T - Rare or likely to become extinct  
X - Presumed extinct  
IA - Protected under international agreement  
S - Other specially protected fauna  
1 - Priority 1  
2 - Priority 2  
3 - Priority 3  
4 - Priority 4  
5 - Priority 5

<sup>1</sup> For NatureMap's purposes, species flagged as endemic are those whose records are wholly contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

# Appendix C – Vegetation Data

Relevé Data

ID	Family	Taxon	Status	Stratum	Cover (%)	Height (m)
R1	Proteaceae	<i>Banksia attenuata</i>		Upper	30_10	10
R1	Proteaceae	<i>Banksia ilicifolia</i>		Upper	30_10	10
R1	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	70_30	8
R1	Loranthaceae	<i>Nuytsia floribunda</i>		Upper	<2T10	10
R1	Iridaceae	<i>Patersonia occidentalis</i>		Lower	<10	0.5
R1	Restionaceae	<i>Desmocladius flexuosus</i>		Lower	70_30	0.3
R1	Dilleniaceae	<i>Hibbertia hypericoides</i>		Lower	<2N	0.5
R1	Fabaceae	<i>Hovea trisperma</i>		Lower	<2T10	0.2
R1	Poaceae	<i>Briza maxima</i>	*	Lower	<2N	0.2
R1	Fabaceae	<i>Gompholobium tomentosum</i>		Lower	<2T10	0.2
R1	Proteaceae	<i>Petrophile linearis</i>		Lower	<2T10	0.3
R1	Anarthriaceae	<i>Lyginia barbata</i>		Lower	<10	0.3
R1	Zamiaceae	<i>Macrozamia riedlei</i>		Lower	<10	0.5
R1	Myrtaceae	<i>Calytrix angulata</i>		Lower	<10	0.1
R1	Myrtaceae	<i>Melaleuca thymoides</i>		Mid	<10	1.5
R1	Colchicaceae	<i>Burchardia congesta</i>		Lower	<2T10	0.5
R1	Asparagaceae	<i>Lomandra caespitosa</i>		Lower	<2N	0.3
R1	Stylidiaceae	<i>Stylidium brunonianum</i>		Lower	<10	0.3
R1	Ericaceae	<i>Leucopogon parviflorus</i>		Lower	<2T10	0.2
R1	Proteaceae	<i>Banksia menziesii</i>		Upper	30_10	8
R1 opp	Casuarinaceae	<i>Allocasuarina fraseriana</i>		Upper	opp	15
R1 opp	Dasypogonaceae	<i>Dasypogon bromeliifolius</i>		Lower	opp	0.5
R1 opp	Hemerocallidaceae	<i>Johnsonia pubescens</i> subsp. <i>cygnorum</i>	P2	Lower	opp	0.3
R1 opp	Dilleniaceae	<i>Hibbertia vaginata</i>		Lower	opp	0.3
R1 opp	Xanthorrhoeaceae	<i>Xanthorrhoea preissii</i>		Mid	opp	1
R1 opp	Hemerocallidaceae	<i>Tricoryne elatior</i>		Lower	opp	0.3
R2	Myrtaceae	<i>Corymbia calophylla</i>		Upper	<10	20

ID	Family	Taxon	Status	Stratum	Cover (%)	Height (m)
R2	Loranthaceae	<i>Nuytsia floribunda</i>		Upper	<2T10	15
R2	Xanthorrhoeaceae	<i>Xanthorrhoea preissii</i>		Mid	<10	1.5
R2	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	70_30	3
R2	Orobanchaceae	<i>Orobanche minor</i>	*	Lower	<2N	0.3
R2	Asteraceae	<i>Ursinia anthemoides</i>	*	Lower	<10	0.1
R2	Poaceae	<i>Ehrharta calycina</i>	*	Lower	<2N	0.3
R2	Dilleniaceae	<i>Hibbertia hypericoides</i>		Lower	<2N	0.5
R2	Commelinaceae	<i>Cartonema philydroides</i>		Lower	<2N	0.3
R2	Poaceae	<i>Rytidosperma</i> sp.		Lower	<2N	0.3
R2	Restionaceae	<i>Desmocladius flexuosus</i>		Lower	<2N	0.1
R2	Poaceae	<i>Aira caryophyllea</i>	*	Lower	<2N	0.1
R2 opp	Asteraceae	<i>Sonchus oleraceus</i>	*	Lower	opp	0.2
R2 opp	Solanaceae	<i>Solanum nigrum</i>	*	Lower	opp	0.2
R2 opp	Proteaceae	<i>Stirlingia latifolia</i>		Lower	opp	0.5
R2 opp	Asteraceae	<i>Podotheca angustifolia</i>		Lower	opp	0.2
R2 opp	Asteraceae	<i>Hyalosperma cotula</i>		Lower	opp	0.1
R2 opp	Primulaceae	<i>Lysimachia arvensis</i>	*	Lower	opp	0.1
R2 opp	Araceae	<i>Zantedeschia aethiopica</i>	*DP	Lower	opp	0.5
R2 opp	Asparagaceae	<i>Dichopogon capillaris</i>		Lower	opp	0.3
R2 opp	Asteraceae	<i>Lagenophora huegelii</i>		Lower	opp	0.1
R2 opp	Fabaceae	<i>Hardenbergia comptoniana</i>		Lower	opp	cr
R2 opp	Asteraceae	<i>Arctotheca calendula</i>	*	Lower	opp	0.1
R2 opp	Geraniaceae	<i>Pelargonium capitatum</i>	*	Lower	opp	0.2
R3	Myrtaceae	<i>Eucalyptus rudis</i>		Upper	30_10	20
R3	Myrtaceae	<i>Melaleuca preissiana</i>		Upper	30_10	10
R3	Xanthorrhoeaceae	<i>Xanthorrhoea preissii</i>		Mid	30_10	1.5
R3	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	70_30	8

ID	Family	Taxon	Status	Stratum	Cover (%)	Height (m)
R3	Iridaceae	<i>Patersonia occidentalis</i>		Lower	<10	0.5
R3	Cyperaceae	<i>Lepidosperma</i> sp.		Lower	30_10	0.5
R3	Restionaceae	<i>Leptocarpus coangustus</i>		Lower	<10	0.5
R3	Juncaceae	<i>Juncus pallidus</i>		Lower	<10	0.5
R3	Asteraceae	<i>Ursinia anthemoides</i>	*	Lower	<2N	0.2
R3	Dilleniaceae	<i>Hibbertia hypericoides</i>		Lower	<2N	0.2
R3	Commelinaceae	<i>Cartonema philydroides</i>		Lower	<2N	0.2
R3	Fabaceae	<i>Acacia saligna</i>		Mid	<2T10	1
R3	Araliaceae	<i>Trachymene pilosa</i>		Lower	<2N	0.1
R3	Poaceae	<i>Ehrharta calycina</i>	*	Lower	<2N	0.2
R3	Dennstaedtiaceae	<i>Pteridium esculentum</i>		Lower	<10	0.5
R3	Cyperaceae	<i>Mesomelaena pseudostygia</i>		Lower	<2T10	0.5
R3	Orchidaceae	<i>Pyrorchis nigricans</i>		Lower	<2T10	0.1
R3	Asparagaceae	<i>Laxmannia squarrosa</i>		Lower	<2T10	0.1
R3	Violaceae	<i>Hybanthus calycinus</i>		Lower	<2T10	0.2
R3 opps	Asparagaceae	<i>Asparagus asparagoides</i>	*DP & WoNS	Lower	opp	cr
R3 opps	Casuarinaceae	<i>Allocasuarina fraseriana</i>		Upper	opp	15
R3 opps	Myrtaceae	<i>Corymbia calophylla</i>		Upper	opp	20
R4	Myrtaceae	<i>Eucalyptus marginata</i>		Upper	<10	20
R4	Casuarinaceae	<i>Allocasuarina fraseriana</i>		Upper	30_10	15
R4	Proteaceae	<i>Banksia menziesii</i>		Upper	30_10	10
R4	Proteaceae	<i>Banksia ilicifolia</i>		Upper	<10	10
R4	Proteaceae	<i>Banksia attenuata</i>		Upper	30_10	10
R4	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	30_10	3
R4	Proteaceae	<i>Stirlingia latifolia</i>		Lower	30_10	0.5
R4	Proteaceae	<i>Petrophile linearis</i>		Lower	<10	0.2
R4	Restionaceae	<i>Desmocladius flexuosus</i>		Lower	30_10	0.1

ID	Family	Taxon	Status	Stratum	Cover (%)	Height (m)
R4	Dasygogonaceae	<i>Dasygogon bromeliifolius</i>		Lower	30_10	0.2
R4	Dilleniaceae	<i>Hibbertia vaginata</i>		Lower	<2N	0.3
R4	Asteraceae	<i>Hyalosperma cotula</i>		Lower	<2T10	0.1
R4	Iridaceae	<i>Patersonia occidentalis</i>		Lower	<10	0.3
R4 opp	Hemerocallidaceae	<i>Tricoryne elatior</i>		Lower	opp	0.1
R4 opp	Droseraceae	<i>Drosera</i> sp.		Lower	opp	0.1
R4 opp	Xanthorrhoeaceae	<i>Chamaescilla corymbosa</i>		Lower	opp	0.1
R4 opp	Orchidaceae	<i>Prasophyllum</i> sp.		Lower	opp	0.1
R4 opp	Stylidiaceae	<i>Stylidium</i> sp.		Lower	opp	0.1
R4 opp	Asteraceae	<i>Ursinia anthemoides</i>	*	Lower	opp	0.1
R4 opp	Colchicaceae	<i>Burchardia congesta</i>		Lower	opp	0.2
R4 opp	Proteaceae	<i>Xylomelum occidentale</i>		Upper	opp	8
R4 opp	Haemodoraceae	<i>Conostylis juncea</i>		Lower	opp	0.2
R4 opp	Asparagaceae	<i>Thysanotus ?arenarius</i>		Lower	opp	0.2
R4 opp	Restionaceae	<i>Desmocladius fasciculatus</i>		Lower	opp	0.1
R4 opp	Poaceae	<i>Austrostipa compressa</i>		Lower	opp	0.2
R4 opp	Polygalaceae	<i>Comesperma calymega</i>		Lower	opp	0.2
R5	Myrtaceae	<i>Corymbia calophylla</i>		Upper	<2T10	15
R5	Myrtaceae	<i>Melaleuca preissiana</i>		Upper	30_10	10
R5	Cyperaceae	<i>Lepidosperma</i> sp.		Lower	<10	0.5
R5	Xanthorrhoeaceae	<i>Xanthorrhoea preissii</i>		Mid	<10	1.5
R5	Poaceae	<i>Briza maxima</i>	*	Lower	<2N	0.3
R5	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	<2T10	5
R5	Poaceae	<i>Ehrharta calycina</i>	*	Lower	<2T10	0.3
R5	Poaceae	<i>Hordeum leporinum</i>	*	Lower	<2N	0.3
R5	Poaceae	<i>Lolium</i> sp.	*	Lower	<2N	0.3
R5	Restionaceae	<i>Dielsia stenostachya</i>		Lower	70_30	0.2

ID	Family	Taxon	Status	Stratum	Cover (%)	Height (m)
R5	Asteraceae	<i>Ursinia anthemoides</i>	*	Lower	<2N	0.2
R5	Orobanchaceae	<i>Orobanche minor</i>	*	Lower	<2N	0.3
R5	Myrtaceae	<i>Astartea</i> sp.		Mid	30_10	1.5
R5	Dasypogonaceae	<i>Dasypogon bromeliifolius</i>		Lower	<10	0.3
R6	Proteaceae	<i>Banksia attenuata</i>		Upper	<10	12
R6	Proteaceae	<i>Banksia ilicifolia</i>		Upper	30_10	10
R6	Myrtaceae	<i>Melaleuca preissiana</i>		Upper	<10	10
R6	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	70_30	5
R6	Asteraceae	<i>Zantedeschia aethiopica</i>	*DP	Lower	<10	0.5
R6	Dasypogonaceae	<i>Dasypogon bromeliifolius</i>		Lower	30_10	0.3
R6	Poaceae	<i>Ehrharta calycina</i>	*	Lower	<2N	0.3
R6	Asteraceae	<i>Ursinia anthemoides</i>	*	Lower	<2N	0.2
R6	Poaceae	<i>Bromus diandrus</i>	*	Lower	<2N	0.2
R6	Hemerocallidaceae	<i>Tricoryne elatior</i>		Lower	<2T10	0.2
R6	Myrtaceae	<i>Eucalyptus marginata</i>		Upper	<2T10	10
R6	Restionaceae	<i>Desmocladius fasciculatus</i>		Lower	<2N	0.2
R7	Proteaceae	<i>Banksia ilicifolia</i>		Upper	<10	15
R7	Proteaceae	<i>Banksia menziesii</i>		Upper	<2N	10
R7	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	70_30	5
R7	Poaceae	<i>Briza maxima</i>	*	Lower	<2N	0.2
R7	Asteraceae	<i>Ursinia anthemoides</i>	*	Lower	<2N	0.2
R7	Dasypogonaceae	<i>Dasypogon bromeliifolius</i>		Lower	<10	0.3
R7	Restionaceae	<i>Desmocladius flexuosus</i>		Lower	30_10	0.2
R7	Proteaceae	<i>Banksia attenuata</i>		Upper	<2T10	10
R7	Araceae	<i>Zantedeschia aethiopica</i>	*DP	Lower	<2N	0.5
R8	Proteaceae	<i>Banksia ilicifolia</i>		Upper	30_10	12
R8	Proteaceae	<i>Banksia menziesii</i>		Upper	<10	10

ID	Family	Taxon	Status	Stratum	Cover (%)	Height (m)
R8	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	70_30	5
R8	Restionaceae	<i>Desmocladius flexuosus</i>		Lower	30_10	0.3
R8	Dasypogonaceae	<i>Dasypogon bromeliifolius</i>		Lower	30_10	0.3
R8	Araliaceae	<i>Trachymene pilosa</i>		Lower	<2N	0.1
R8	Myrtaceae	<i>Melaleuca thymoides</i>		Mid	<2N	1.5
R8	Proteaceae	<i>Banksia attenuata</i>		Upper	<2N	8
R8	Hemerocallidaceae	<i>Corynotheca micrantha</i>		Lower	30_10	0.2
R8	Violaceae	<i>Hybanthus calycinus</i>		Lower	<10	0.2
R9	Proteaceae	<i>Banksia menziesii</i>		Upper	<10	8
R9	Casuarinaceae	<i>Allocasuarina fraseriana</i>		Upper	30_10	10
R9	Myrtaceae	<i>Eucalyptus marginata</i>		Upper	30_10	20
R9	Proteaceae	<i>Banksia attenuata</i>		Upper	<10	10
R9	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	30_10	4
R9	Proteaceae	<i>Adenanthos cygnorum</i>		Mid	<10	2
R9	Dasypogonaceae	<i>Dasypogon bromeliifolius</i>		Lower	<10	0.5
R9	Iridaceae	<i>Patersonia occidentalis</i>		Lower	30_10	0.5
R9	Myrtaceae	<i>Calytrix angulata</i>		Lower	30_10	0.2
R9	Asparagaceae	<i>Thysanotus ?arenarius</i>		Lower	<10	0.1
R9	Restionaceae	<i>Desmocladius flexuosus</i>		Lower	30_10	0.2
R9	Fabaceae	<i>Gompholobium tomentosum</i>		Lower	30_10	0.2
R9	Xanthorrhoeaceae	<i>Chamaescilla corymbosa</i>		Lower	<10	0.1
R9	Dilleniaceae	<i>Hibbertia hypericoides</i>		Lower	<2N	0.5
R9	Proteaceae	<i>Petrophile linearis</i>		Lower	<2N	0.3
R9	Droseraceae	<i>Drosera</i> sp.		Lower	<2T10	0.1
R9	Ericaceae	Ericaceae sp.		Lower	<2T10	0.3
R9	Proteaceae	<i>Stirlingia latifolia</i>		Mid	<2T10	1
R9	Myrtaceae	<i>Melaleuca thymoides</i>		Mid	<2T10	1.5

ID	Family	Taxon	Status	Stratum	Cover (%)	Height (m)
R9	Dilleniaceae	<i>Hibbertia vaginata</i>		Lower	<2T10	0.3
R9	Hemerocallidaceae	<i>Tricoryne elatior</i>		Lower	<2T10	0.1
R9	Haemodoraceae	<i>Conostylis aculeata</i>		Lower	<2T10	0.1
R10	Myrtaceae	<i>Eucalyptus rudis</i>		Upper	70_30	25
R10	Myrtaceae	<i>Astartea</i> sp.		Mid	30_10	2
R10	Cyperaceae	<i>Lepidosperma longitudinale</i>		Mid	<10	2
R10	Dennstaedtiaceae	<i>Pteridium esculentum</i>		Mid	100_70	1.5
R10	Papaveraceae	<i>Fumaria capreolata</i>	*	Lower	<10	0.3
R10	Fabaceae	<i>Acacia saligna</i>		Mid	<2T10	1.5
R10	Oxalidaceae	<i>Oxalis pes-caprae</i>	*	Lower	<2T10	0.1
R10	Juncaginaceae	<i>Triglochin</i> sp.		Lower	<10	0.3
R10 opp	Proteaceae	<i>Banksia grandis</i>		Upper	opp	10
R10 opp	Cyperaceae	<i>Ficinia nodosa</i>		Mid	opp	1.5
R11	Myrtaceae	<i>Melaleuca preissiana</i>		Upper	30_10	10
R11	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	<2N	5
R11	Restionaceae	<i>Dielsia stenostachya</i>		Lower	100_70	0.2
R11	Restionaceae	<i>Hypolaena exsulca</i>		Lower	30_10	0.2
R11	Poaceae	<i>Bromus diandrus</i>	*	Lower	<10	0.2
R11	Poaceae	<i>Ehrharta calycina</i>	*	Lower	<10	0.2
R11	Asteraceae	<i>Hypochaeris glabra</i>	*	Lower	<10	0.1
R11	Poaceae	<i>Briza maxima</i>	*	Lower	<10	0.2
R11	Araceae	<i>Zantedeschia aethiopica</i>	*DP	Lower	<2T10	0.5
R11	Xanthorrhoeaceae	<i>Xanthorrhoea preissii</i>		Lower	<2T10	0.5
R11	Poaceae	<i>Lolium</i> sp.		Lower	<2N	0.3
R11	Caryophyllaceae	<i>Cerastium glomeratum</i>	*	Lower	<2N	0.2
R11	Poaceae	<i>Briza minor</i>	*	Lower	<2N	0.2
R11	Iridaceae	<i>Patersonia occidentalis</i>		Lower	<2N	0.5

ID	Family	Taxon	Status	Stratum	Cover (%)	Height (m)
R11	Asteraceae	<i>Arctotheca calendula</i>	*	Lower	<2N	0.2
R12	Myrtaceae	<i>Eucalyptus rudis</i>		Upper	30_10	20
R12	Myrtaceae	<i>Melaleuca preissiana</i>		Upper	30_10	10
R12	Myrtaceae	<i>Melaleuca raphiophylla</i>		Upper	30_10	8
R12	Restionaceae	<i>Dielsia stenostachya</i>		Lower	100_70	0.2
R12	Restionaceae	<i>Hypolaena exsulca</i>		Lower	30_10	0.2
R12	Cyperaceae	<i>Lepidosperma</i> sp.		Lower	<10	0.5
R12	Orchidaceae	Orchidaceae sp.		Lower	<10	0.5
R12	Araceae	<i>Zantedeschia aethiopica</i>	*DP	Lower	<2N	0.3
R12	Poaceae	<i>Lolium</i> sp.	*	Lower	<2N	0.3
R12	Poaceae	<i>Briza maxima</i>	*	Lower	<2N	0.3
R12	Poaceae	<i>Bromus diandrus</i>	*	Lower	<2N	0.5
R12	Asteraceae	<i>Conyza sumatrensis</i>	*	Lower	<2N	0.3
R12	Violaceae	<i>Hybanthus calycinus</i>		Lower	<2N	0.3
R12	Poaceae	<i>Briza minor</i>	*	Mid	<10	1.5
R12	Juncaceae	<i>Juncus pallidus</i>		Mid	<2T10	1.5
R12	Asparagaceae	<i>Thysanotus ?arenarius</i>		Lower	<2T10	0.3
R12	Hemerocallidaceae	<i>Caesia occidentalis/micrantha</i>		Lower	<2T10	0.3
R12	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	<2T10	4
R13	Proteaceae	<i>Banksia ilicifolia</i>		Upper	30_10	15
R13	Proteaceae	<i>Banksia menziesii</i>		Upper	<10	12
R13	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	70_30	5
R13	Dennstaedtiaceae	<i>Pteridium esculentum</i>		Mid	70_30	1.5
R13	Poaceae	<i>Briza maxima</i>	*	Lower	<2N	0.3
R13	Araceae	<i>Zantedeschia aethiopica</i>	*DP	Lower	<2N	0.5
R13	Dasypogonaceae	<i>Dasypogon bromeliifolius</i>		Lower	<2N	0.5
R13	Proteaceae	<i>Banksia attenuata</i>		Upper	<10	8

ID	Family	Taxon	Status	Stratum	Cover (%)	Height (m)
R14	Casuarinaceae	<i>Allocasuarina fraseriana</i>		Upper	<10	15
R14	Proteaceae	<i>Banksia attenuata</i>		Upper	30_10	10
R14	Proteaceae	<i>Banksia menziesii</i>		Upper	30_10	10
R14	Proteaceae	<i>Xylomelum occidentale</i>		Upper	<10	10
R14	Myrtaceae	<i>Eucalyptus marginata</i>		Upper	30_10	15
R14	Xanthorrhoeaceae	<i>Xanthorrhoea preissii</i>		Mid	<10	1.5
R14	Proteaceae	<i>Stirlingia latifolia</i>		Lower	30_10	0.5
R14	Ericaceae	<i>Leucopogon propinquus</i>		Lower	<2T10	0.5
R14	Araceae	<i>Zantedeschia aethiopica</i>	*DP	Lower	<2N	0.5
R14	Asteraceae	<i>Hypochaeris glabra</i>	*	Lower	<10	0.1
R14	Asteraceae	<i>Ursinia anthemoides</i>	*	Lower	<10	0.2
R14	Poaceae	<i>Briza maxima</i>	*	Lower	<10	0.2
R14	Restionaceae	<i>Desmocladius flexuosus</i>		Lower	<10	0.2
R14	Hemerocallidaceae	<i>Tricoryne elatior</i>		Lower	<2T10	0.2
R14	Poaceae	<i>Ehrharta calycina</i>	*	Lower	<2N	0.3
R14	Asparagaceae	<i>Thysanotus patersonii/manglesianus</i>		Lower	<2T10	CR
R15	Proteaceae	<i>Banksia menziesii</i>		Upper	30_10	8
R15	Proteaceae	<i>Xylomelum occidentale</i>		Upper	30_10	8
R15	Myrtaceae	<i>Eucalyptus marginata</i>		Upper	30_10	20
R15	Proteaceae	<i>Banksia attenuata</i>		Upper	30_10	10
R15	Xanthorrhoeaceae	<i>Xanthorrhoea preissii</i>		Mid	<10	1.5
R15	Casuarinaceae	<i>Allocasuarina fraseriana</i>		Upper	30_10	10
R15	Asteraceae	<i>Hypochaeris glabra</i>	*	Lower	<2N	0.1
R15	Araliaceae	<i>Trachymene pilosa</i>		Lower	<2N	0.1
R15	Asteraceae	<i>Ursinia anthemoides</i>	*	Lower	<2N	0.1
R15	Restionaceae	<i>Desmocladius fasciculatus</i>		Lower	<2N	0.2
R15	Iridaceae	<i>Romulea rosea</i>	*	Lower	<2N	0.1

ID	Family	Taxon	Status	Stratum	Cover (%)	Height (m)
R15	Dilleniaceae	<i>Hibbertia hypericoides</i>		Lower	<2T10	0.3
R15	Asteraceae	<i>Hyalosperma cotula</i>		Lower	<2N	0.1
R15	Asteraceae	<i>Lagenophora huegelii</i>		Lower	<2T10	0.1
R15	Restionaceae	<i>Desmocladius flexuosus</i>		Lower	<2T10	0.2
R15	Proteaceae	<i>Briza maxima</i>	*	Lower	<2T10	0.1
R15	Fabaceae	<i>Kennedia prostrata</i>		Lower	<2T10	cr
R16	Myrtaceae	<i>Melaleuca preissiana</i>		Upper	30_10	10
R16	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	70_30	4
R16	Proteaceae	<i>Xylomelum occidentale</i>		Upper	<2T10	10
R16	Casuarinaceae	<i>Allocasuarina fraseriana</i>		Upper	<2T10	15
R16	Dasypogonaceae	<i>Dasypogon bromeliifolius</i>		Lower	30_10	0.5
R16	Myrtaceae	<i>Calytrix angulata</i>		Lower	30_10	0.2
R16	Anarthriaceae	<i>Lyginia imberbis</i>		Lower	30_10	0.3
R17	Myrtaceae	<i>Melaleuca preissiana</i>		Upper	30_10	12
R17	Proteaceae	<i>Banksia menziesii</i>		Upper	30_10	10
R17	Proteaceae	<i>Banksia attenuata</i>		Upper	<10	10
R17	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	70_30	5
R17	Dasypogonaceae	<i>Dasypogon bromeliifolius</i>		Lower	<10	0.5
R17	Myrtaceae	<i>Astartea</i> sp.		Mid	<10	1
R17	Anarthriaceae	<i>Lyginia imberbis</i>		Lower	<2T10	0.5
R17	Loranthaceae	<i>Nuytsia floribunda</i>		Upper	<2T10	15
R18	Myrtaceae	<i>Corymbia calophylla</i>		Upper	<10	20
R18	Casuarinaceae	<i>Allocasuarina fraseriana</i>		Upper	<10	15
R18	Myrtaceae	<i>Eucalyptus marginata</i>		Upper	<2T10	20
R18	Proteaceae	<i>Banksia menziesii</i>		Upper	30_10	15
R18	Proteaceae	<i>Banksia attenuata</i>		Upper	30_10	15
R18	Proteaceae	<i>Xylomelum occidentale</i>		Upper	<10	10

ID	Family	Taxon	Status	Stratum	Cover (%)	Height (m)
R18	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	70_30	5
R18	Dasypogonaceae	<i>Dasypogon bromeliifolius</i>		Lower	<10	0.3
R18	Xanthorrhoeaceae	<i>Xanthorrhoea preissii</i>		Mid	<2T10	1.5
R18	Anarthriaceae	<i>Lyginia imberbis</i>		Lower	<2T10	0.3
R18	Proteaceae	<i>Banksia grandis</i>		Upper	<2T10	8
R18	Restionaceae	<i>Desmocladius flexuosus</i>		Lower	<2T10	0.3
R18	Iridaceae	<i>Patersonia occidentalis</i>		Lower	<2T10	0.3
R19	Casuarinaceae	<i>Allocasuarina fraseriana</i>		Upper	<10	15
R19	Proteaceae	<i>Banksia menziesii</i>		Upper	30_10	15
R19	Myrtaceae	<i>Eucalyptus marginata</i>		Upper	<10	20
R19	Proteaceae	<i>Banksia attenuata</i>		Upper	30_10	10
R19	Proteaceae	<i>Xylomelum occidentale</i>		Upper	<10	10
R19	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	30_10	5
R19	Iridaceae	<i>Patersonia occidentalis</i>		Lower	70_30	0.5
R19	Proteaceae	<i>Stirlingia latifolia</i>		Lower	30_10	0.5
R19	Restionaceae	<i>Desmocladius flexuosus</i>		Lower	30_10	0.3
R19	Zamiaceae	<i>Macrozamia riedlei</i>		Lower	<10	0.3
R19	Violaceae	<i>Hybanthus calycinus</i>		Lower	<10	0.2
R19	Dasypogonaceae	<i>Dasypogon bromeliifolius</i>		Lower	<10	0.5
R19	Dilleniaceae	<i>Hibbertia hypericoides</i>		Lower	<10	0.5
R19	Proteaceae	<i>Petrophile linearis</i>		Lower	<2T10	0.2
R19	Xanthorrhoeaceae	<i>Xanthorrhoea preissii</i>		Lower	<2T10	0.5
R20	Myrtaceae	<i>Corymbia calophylla</i>		Upper	30_10	20
R20	Myrtaceae	<i>Eucalyptus marginata</i>		Upper	30_10	20
R20	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	70_30	5
R20	Fabaceae	<i>Acacia floribunda</i>	*	Upper	<2T10	5
R20	Proteaceae	<i>Banksia ilicifolia</i>		Upper	<2T10	10

ID	Family	Taxon	Status	Stratum	Cover (%)	Height (m)
R20	Poaceae	<i>Briza maxima</i>	*	Lower	30_10	0.2
R20	Fabaceae	<i>Hardenbergia comptoniana</i>		Lower	<2T10	CR
R21	Myrtaceae	<i>Melaleuca preissiana</i>		Upper	30_10	10
R21	Myrtaceae	<i>Eucalyptus marginata</i>		Upper	<2T10	20
R21	Myrtaceae	<i>Corymbia calophylla</i>		Upper	30_10	20
R21	Myrtaceae	<i>Kunzea glabrescens</i>		Upper	100_70	5
R21	Fabaceae	<i>Acacia saligna</i>		Upper	<10	3
R21	Dennstaedtiaceae	<i>Pteridium esculentum</i>		Lower	100_70	0.5
R21	Xanthorrhoeaceae	<i>Xanthorrhoea preissii</i>		Mid	<2T10	2